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Philosophical Principles

OF

MEDICINE,

IN

THREE PARTS.

CONTAINING,

I. A Demonstration of the general LAWS of GRAVITY, with their Effects upon Animal Bodys.

II. The more particular LAWS which obtain in the Motion and Secretion of the vital Fluids, applied to the principal Diseases and Irregularitys of the Animal Machine.

III. The primary and chief Intentions of Medicine in the Cure of Diseases, problematically propos'd and mechanically resolv'd.

By *THO. MORGAN*, M.D.

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M.DCC.XXV.

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To the most Honoured

Sir *HANS SLOAN*, Kt. President of the Royal College of Physicians in *London*; and the rest of the much Honoured Members of that SOCIETY.

Most and much Honoured,

THE Motive of a Dedication is commonly either Gratitude or Interest, and very often both Accounts are prudently summ'd up in one; and the Author with great Modesty desires, that what he offers may be taken in part of Payment for Favours already receiv'd, and at the same time be look'd upon as a valuable Consideration for those that are yet behind.

For my own part, I design this Address neither as a Debt nor a Petition; but as a fair and equitable Appeal to you who are the proper Judges, whether this way of treating the Subject, is likely to be of any real Use or Advantage in the Theory and Practice of Medicine.

But whatever the Merits of the Cause be, the Equity and Fairness of the Appeal must certainly be allow'd; for as I can herein claim no benefit from the Honour of any particular personal Acquaintance or Friendship, so I desire no better Protection against malevolent Censure: and thus far I am secure, under the Patronage of the most learned and illustrious Body of Physicians in the World; since, upon this foot, to beg your Favour, would be in effect to impeach your Justice.

You are sufficiently sensible that no Improvement of any sort can be made,

made, where a rational freedom of Inquiry is deny'd; and I cannot but mention here, what redounds so much to your Honour, that you have ever acted upon this noble and generous Principle. You have the Health and Ease, the Lives and Happiness of your fellow Creatures too near at heart, than to sacrifice those valuable Interests to any darling Hypothesis, indisputably receiv'd, and establish'd into a System of Physical Orthodoxy.

'Tis from this liberty of reasoning, and a right application of it, that Medicine begins now to arise out of its antient Chaos, and from the Advancements already made to give us the promising Hopes of its appearing some time or other as a real SCIENCE. 'Tis from hence that this excellent and useful Subject has of late Years been rescu'd in great measure from the violent Hands of chymical and metaphysical Empyricism; by which every thing was explain'd into Darkness, and the

Knowledge of the Diſeaſe loſt in the myſterious Diſquiſition of the Cauſe.

If I have here contributed any thing towards the ſetting this moſt neceſſary part of natural Philoſophy in a clearer Light, or towards the engaging ſome abler Pen to undertake a more complete Work of the ſame kind, my Deſign in it will be ſufficiently anſwer'd: But if I ſhould unhappily fail of any ſuch Succeſs, I doubt not but you will at leaſt pardon the freedom of the Attempt, in conſequence of the goodneſs of the Intention. I am,

GENTLEMEN,

Your moſt Obedient

Humble Servant,

Tho. Morgan.

THE PREFACE.

MENS ſana in corpore ſano, *is a ſhort but full Deſcription of human Felicity, or of the Happineſs of Man as he is a Creature compounded of Soul and Body. And next to the Knowledge of God, of our Duty to him, and the means of obtaining the divine Favour; the Knowledge of the Principles and Laws of Motion, as apply'd to the Structure and Operations of the Animal Body, in order to prevent or remove the Diſeaſes and Irregularitys to which it is liable, and maintain it in as ſound and uninterrupted a* ſtate of Health *as poſſible, is doubtleſs the moſt excellent and uſeful.*

THAT the animal Body is a pure Machine, and that all its Operations and Phænomena, with the ſeveral changes which happen to it, are the neceſſary reſult of its Organization and Structure, is now generally known, and confirmed beyond all contradiction by the modern Obſervations and Improvements in Anatomy.

THE Life of an Animal, as far as it falls under a medical Consideration, consists in the Circulation of the Blood; and Death is nothing else but a cessation of that Motion, or a stagnation of the animal Fluids. Health is the uniform Circulation of the Blood, and the consequent Derivation of the several Liquors secreted by the Glands, in their natural and due Proportions: and any irregularity of excess or defect herein, induces some Sickness or Diseases. Such is the surprizing minuteness and nice adjustment of the numberless Springs and Movements upon which Life depends; and so many the Irregularitys to which every one of them is liable, that the Preservation of this curious piece of Machinery, and the continuance of its Operations and Functions for three or fourscore Years together, is little less than a Miracle: at least, every one must allow it as a convincing Proof of the inimitable Wisdom and Contrivance of its Author and Former.

AND here I must observe, what one cannot reflect upon without wonder; That the animal Automaton *is contriv'd and adjusted upon Principles of Self-preservation: 'tis form'd and design'd for the helping it self, and laid under a sort of mechanical necessity of regulating its own Motions. There is no Disorder which happens to it, but there is at the same time a considerable effort of Nature, i.e. of the Machine, to rectify the*

Error, and restore the soundness of its Constitution. And herein this noble Machine of an animated Body, which is the perfect Workmanship of almighty God, differs from the most finish'd Pieces of Art, and every thing of human Contrivance; since in the most complete and admired Productions of this latter kind, there is not the least appearance, no traces or footsteps of this self-preserving or self-restoring Principle to be found. Any Irregularitys happening to a Clock, a Watch, or other piece of Mechanism, which is the result of Art and human Contrivance, must necessarily continue, and disturb the Motions of the whole, till it be set right by the Hand and Skill of the Artist. There is no power or tendency in the Machine to restore or rectify it self; and 'tis impossible, for instance, that a Disorder or Defect in the Pendulum should be rectify'd or adjusted by the Motion of any other part. But the animal Machine is contriv'd and adjusted with such a wonderful harmony and connexion of its several Organs and Functions, that an irregular or diseased Motion in one part, necessarily excites such Motions in other parts, as tend to rectify the first Disorder, and set all right in a natural way, without any foreign extrinsick aid or assistance from Art. This natural necessary Conatus *or Effort in the animal Machine towards Health and Rectitude, is sufficiently evident in Fact, being a matter of common*

Obser-

Observation and Experience which no body can deny. Every one talks of Nature's helping it self, and of the efforts or endeavours of Nature to throw off the Disease; but the Grounds and Principles of this, how it happens, or by what Mechanism and Contrivance it is brought about, have not been enough, and can never be too much consider'd by the Physicians. To set this part of the Animal Oeconomy in a clearer Light, is partly the design of the following Propositions; but all the use I shall make of it here, is to observe how necessary it is for a Physician to be well acquainted with the Principles and Laws of Motion, together with the Constitution and Structure of animal Bodys, and the application of one to the other. For since the animal Body is a Machine, and Diseases are nothing else but its particular Irregularitys, Defects and Disorders, a blind Man might as well pretend to regulate a piece of Clock-work, or a deaf Man to tune an Organ, as a Person ignorant of Mathematicks and Mechanism to cure Diseases, without understanding the natural Organization, Structure, and Operations of the Machine which he undertakes to regulate.

AS there are two things necessary to constitute a good Philosopher, namely, a just acquaintance with the Phænomena of Nature, grounded upon accurate Observations and Experiments, and a competent skill in Arithmetick, Geometry and Algebra, to enable him

him to reduce the Forces and Operations of Bodys to a Calculus, *in order to find out the adequation and proportion between the natural Cauſes and their Effects: ſo the like Mathematical and Mechanical Reaſoning, join'd with the Hiſtory of Diſeaſes, their Symptoms and Cure, drawn from Experience, are both neceſſary in Phyſicians, and one without the other is altogether inſufficient. It is a little ſurprizing therefore to hear ſome Gentlemen of the Faculty declaim againſt Mathematical and Mechanical Theories* in Re Medica, *ſince this is in effect to maintain, that Medicine is grounded upon no Principle at all; that if Diſeaſes are cured, it muſt be by chance; and that conſequently there is no difference but that of a* Diploma *between a Phyſician and a Quack. 'Tis evident to all experience, that new Species of Diſeaſes, or new Symptoms attending the ſame Diſeaſes, daily ariſe and offer themſelves in the Practice of every Phyſician, in which the Hiſtorys of Diſeaſes can be of little uſe: and in this caſe, where Experience fails, as it will in a thouſand Inſtances, every one, how much ſoever he may declaim againſt Theorys, preſently recurs to his own Theory, ſuch as it is, true or falſe, right or wrong, and accordingly attempts the Cure at leaſt for Experiment's ſake; and ſo the Patient often pays dear for what the Doctor decrys only becauſe he does not underſtand. But I muſt do our Phy-*

Physicians the justice to own, that they now seem pretty generally dispos'd to abandon Mystery for plain Sense, and to substitute demonstrative and experimental Truths, in the room of unintelligible Terms, occult Qualitys, precarious Hypotheses, and that infinite jumble of chymical and metaphysical Jargon, which had a long time passed for the Rationale *of Medicine. A moderate skill in the Mathematicks, and a tolerable acquaintance with the mechanical Powers, begin to be reckon'd a necessary Qualification for one who would make a figure in his Profession: and 'tis to be hop'd, that this, in time, will come to be allow'd as the true Characteristick of a rational Physician, as distinguish'd from an Empyrick. And indeed, since it is the business of a Physician to assist Nature in its Operations under the most nice and difficult Circumstances, it is impossible he should acquit himself herein with satisfaction and success, or act otherwise than at blind random, if he has not the skill of applying, as occasion serves, mathematical Quantitys and Proportions, to the mechanical Powers; upon which all the Laws of the Animal Oeconomy, and the Effects and Consequences of Motion in the mutual Action and Re-action of Bodys, entirely depend.*

FALSE Principles of Reason, and a wrong application of Experiments, have for a long time past effectually darken'd and obscur'd

ſcur'd the real State of Phyſick and Diſeaſes; while Men overlooking and neglecting the moſt obvious and ſenſible Phænomena, have pretended to ſearch into the deep Recondita *and Receſſes of Nature, and explain every thing by Cauſes either wholly imaginary and unintelligible, or which at leaſt if granted and ever ſo well underſtood, could have no manner of relation to the Cure of Diſeaſes: And herein the Gentlemen of the chymical Pharmacy muſt be allow'd to have had their ſhare; who, fir'd with the Expectation of the* Philoſopher's Stone, *and inflated with the vain Conceit of a miraculous Power, have been generally Men of ſtrong Imaginations and weak Judgments; and accordingly the Experiments they have given us concerning the Blood and animal Liquors, rather ſhew what Changes and Alterations may be induced and made upon them by the Force and violent Action of Fire, than what their natural Conſtitution, Textures, and Uſes are. Is it not ſurprizing to ſee a Man turn the animated Body into a chymical Furnace, and attempt to explain all the Phænomena of animal Motion by the mutual Struggles, Fermentations, and Effervеſcences of Acids and Alcalys? as if the animal Syſtem was a mere Laboratory, and the Nerves and Blood-Veſſels fill'd with* Aqua fortis *and* Spirit of Wine. *The animal Spirits have been introduc'd and diſcours'd of as intelligent free Agents, and there is nothing*

nothing that has been thought difficult to account for in the whole Animal Oeconomy, but what has been attributed to the miraculous Power and Operations of these Spirits: when they are pleas'd and in good temper, they are the pacifick Agents and Emissarys of the Soul, they keep all quiet and right within, and bless the animal Kingdom with a chearing, invigorating Warmth and vital Sunshine; on the other hand, they are no sooner disturb'd, enrag'd, and put out of humour, but they presently declare War, and execute their Vengeance by shaking the very Foundations of Nature, and throwing the whole animal Fabrick into Confusion. In a word, the Spirits are call'd up upon all occasions, and employ'd about every thing but what they are capable of effecting; while the obvious sensible Qualitys of the nervous Fluid, and the Purposes to which it serves in the animated Body, have been altogether overlook'd or misunderstood.

THIS pneumatical Contrivance, for explaining every thing by the inexplicable Motion of the Spirits, is not much mended in the Atomical *or* Corpuscularian Hypothesis; *by which others have attempted to found the* Rationale *of Diseases and their Symptoms, in the supposed and barely imaginary Texture and Constitution of the morbifick Matter. Should I here recount all that has been advanc'd in this way, under an appearance and shew of Mechanism, it might*

serve

ſerve perhaps agreeably to entertain the Reader, but could give him no light into the nature of Diſeaſes, or the method of curing them. Did we underſtand the internal Texture and Conſtitution of the Blood and animal Fluids, as exactly as we do the Propertys of a Triangle; and could we examine every Particle in it with our Microſcope, thro all the infinite Diviſions of which Matter is capable; this might doubtleſs furniſh us with an infinite number of very curious and delightful Speculations, but perhaps would contribute very little to the cure of Diſeaſes, which muſt depend not upon the Texture and Conſtitution of the extremely minute and inſenſible parts of the Blood, but upon its ſenſible Qualitys and Effects, as it is liable to the ſame Laws of Motion with all other mix'd and heterogeneous Fluids.

IF the Liver, for inſtance, is obſtructed, it can be of little conſequence to the Phyſician to know the Nature and Conſtitution of the obſtructing Matter, as whether it be Salt or Sulphur, Soap or Tartar, an Acid or an Alcali. He may imagine in this caſe what pleaſes him beſt, but the Cure will be the ſame, if the natural Force or Momentum motus *of the Blood aſſiſted by Medicine, be capable of removing the Obſtruction. The Knowledge of the Organization and Structure of the animated Body, together with the Forces, Velocitys, Quantitys, and*

diffe-

different Determinations of Motion in the circulating Fluids, while they are in their natural State; with what particular Alterations in all or any of these constitute this or the other Disease; is beyond all doubt a Matter of vastly greater consequence than the Dissection of Atoms, or an intricate useless Inquiry concerning the Texture and Cohesion of certain minute and invisible Particles, which are too fine for our Sight, even when assisted with the best Microscopes.

IT is great pity that the Sagacity and Invention of very learned and ingenious Men should be turned a wrong way, and employ'd about things which are either altogether precarious and uncertain, or which if they should be suppos'd true and capable of Demonstration, could be of little use in the Practice of Medicine. When a Man is told that the acute Pains which are sometimes felt in the Joynts and Tendons, are occasion'd by certain little sharp Wedges, or saline Spiculæ, *which prick and wound the tender Filaments and nervous Coats of the Vessels, he is dispos'd without scruple to give into such an account of the Matter, as extremely plausible, at least; and yet 'tis certain, that any Fluid, with a sufficient quantity of Motion, whatever the Figure and Texture of its Parts be, may distend and overstrain the Vessels, tear and wound their minute Fibres, and by a separation of*

Con-

Continuity occaſion Pain: in which caſe to infer barely from the Phænomenon or Symptom of Pain, that the material Cauſe muſt be Salt, is juſt as good a Conſequence as it would be to conclude, that Fire is a Salt becauſe it occaſions Pain.

IT is certain in fact, that Salts, both fix'd and volatile, are often very efficacious in removing many of thoſe Diſeaſes the Cauſe of which is attributed to Salts; and it would be of no conſequence here to ſay, that Salts of one Figure and Texture may be proper to drive out and diſlodge the Salts of a different kind: for ſince we know but little or nothing of the ultimate Figures and Textures of any Salts, when they are alter'd by and diſſolv'd in the Blood, this would be only to run the account of the Matter into the dark, and render the Cauſe more inexplicable than the Diſeaſes; for it muſt ſtill appear very wonderful, that Diſeaſes ſhould be cur'd by increaſing the morbifick Matter.

A LATE ingenious Theoriſt, being convinc'd of the Weakneſs and Inſufficiency of the common Hypotheſis concerning the animal Spirits, took the Courage and Reſolution, in deſpite of the popular Torrent, to throw them quite off, and leave them out of his Account in the Theory of Diſeaſes: but then he introduces the bilioſe Salts *in their room; and whether upon this occaſion he has not coin'd a new Hypotheſis, equally abſurd, immechanical, and unphiloſophical with*

the other, must be left to the Judgment of the learned World. But for my own part, I must acknowledge, such is the dulness of my Apprehension, or the difficulty of the Subject, that what this Gentleman has said of the bilious Salts, *appears to me altogether as mysterious and miraculous, as the Accounts which others had given concerning the incomprehensible Operations of the* animal Spirits.

HOW these bilious Salts should come to exert their principal Action upon the Stomach, which does not seem to be the natural seat of their Residence; after what manner they should be from thence froth'd into the Blood, and by what Mechanism they are there alternately expanded and contracted, so as to become the chief Instruments of muscular Motion, as well of that which is natural, necessary and uniform, as of that which is voluntary, and under the command of the Will; by what means these bilious Salts should bring a Man to sleep and then awake him again, first raise and exasperate, and then sink and moderate the Passions, and be the great Instruments of Thought, Intelligence and Cogitation, as seated in the Stomach; these are beyond all dispute very deep Speculations, which require a farther Explication, and for which the Publick would certainly be much oblig'd to this great and learned Physician.

I WOULD not have this pass as a Reflection on a Gentleman, of whose Abilitys in general I am very well satisfy'd; I am ever apt to suspect my own Understanding and Judgment, when they happen to be contrary to the Opinion of greater Men: but this ought not to encourage a criminal Modesty, *or any such over-scrupulous Civility as might be an injury to Truth, or detrimental to Mankind; especially since the Gentleman I here aim at, has certainly taken a much greater freedom with others, than I am willing to take with him. And if upon such an occasion he met with some usages not very civil, I doubt not but his Generosity, good Sense, and acquaintance with human Nature, will dispose him to Forgiveness.*

ONE thing, however, the Publick ought to be satisfy'd in, as being a Matter of high consequence, and that is this, whether these bilious Salts, in this large extensive account of them, be not altogether as unintelligible, immechanical and useless, as the common Hypothesis concerning the animal Spirits.

THE necessity or usefulness of Theorys in general, and the possibility or impossibility of investigating the Causes *of Diseases, being now brought into question, and made a sort of Controversy or Party Quarrel among the Physicians, it may be proper here briefly to state the Matter in dispute, to account*

for the seeming Difference, and endeavour to reconcile the Partys at variance.

THE Cause *of a Disease may stand either, first, for the intrinsick essential Texture and Constitution of the morbifick Matter, upon the Principles of the* Corpuscularian Philosophy ; *or, secondly, for the primary Seat and original Constitution of the Disease it self, as it internally affects the animal Organs and Fluids, and from which all the Symptoms, or outward sensible Appearances necessarily follow : or lastly, for the remote Occasion, or extrinsick Agency, by which any such Irregularity or Disorder is induced and brought on.*

UNDER the first of these acceptations, the Inquiry concerning the Causes of Diseases, must necessarily be as uncertain and precarious as the Hypothesis upon which it is founded ; the original, intrinsick, and essential Texture and Constitution of Bodys, from which their nominal Essences, common specifick Differences, or sensible Qualitys arise, are but very little or not at all known to us ; and from imaginary Causes, the Effects can only be imaginarily accounted for. From this sort of Philosophy, a great number of general, undefin'd, and therefore unintelligible Terms, have been introduc'd into Physick and the Accounts of Diseases ; such as Tartar, Sulphur, Mercury, Acid, Alcalis, Nitro-sulphureous, Nitro-aereal, Sulphureo-saline Particles, animal Spirits, bilious Salts,

Salts, *with many more of like nature, which signify either just nothing, or, which is the same in effect, any thing at pleasure.*

FROM hence it comes about, that a Theory in Physick often passes only for the Philosophy of Unintelligibles, and is accordingly prejudg'd and decry'd, right or wrong, by some without hearing, as the mere idle Amusement of such as, wanting Business, prefer Imagination to Experience. But they who draw such Consequences from the misfortune of those who have but ill succeeded in their Theorys of Physick, seem not to be aware how effectually they are ridiculing and exposing themselves and their Profession, while they own in effect, that Medicine is nothing else but mere Empyricism, and that all Physicians are equally Quacks, with this only difference, that some Quacks have more Practice and Experience than others.

HOWEVER, it must be allow'd, that in the Sense of the Word, as last defin'd, the Causes *of Diseases are to us unknown, and ever will be so; nor is it perhaps any great matter whether they are known or unknown. But then the* Cause *of a Disease sometimes signifys the original Disease it self, as it internally affects the animal Organs and Fluids; and from which original internal State and Constitution of the Disease, all the Symptoms or outward sensible Appearances must necessarily follow. And this I take to be the true Notion of Causes*

and Effects, so far as the Rationale *of Physick, or any Theory of Medicine is concern'd about them.*

'TIS plain that the Names of Diseases, under their common Acceptation, are affix'd, not to the real internal Constitution, or morbifick State it self, but to the Complication of Symptoms, or outward sensible Appearances; which Complication of Symptoms, join'd together under a common Name, constitutes the complex Idea, or nominal Essence of this or the other particular Sort or Species of Diseases. Thus when the biliary Ducts, or Pipes which convey the Bile from the Liver to the Intestines, are obstructed, the consequent Symptoms, such as the Yellowness, the hard white Stools, the Costiveness, the thick turbid Urines, with the other Symptoms usually attending the Disease, being join'd together under a common Name and complex Idea, is called the Jaundice ; *which Disease would pass under the same Name, and admit of the same Cure, tho the Cause of it, or the Obstruction of the biliary Pipes should be absolutely unknown, or never once thought of. But then 'tis plain in this case, that the Obstruction of the Bile is strictly and properly the Disease ; and the Complication of Symptoms, to which the Name is affix'd in common Acceptation, are only the Effects and Consequence of it. And after the same manner, any original proper Disease, as it respects the internal State*

and

and Disposition of the Organs and Fluids, may be consider'd as the Cause of the consequent Symptoms. And this Method of reasoning from the Effects to the Cause, *that is, from the Symptoms given to find out the internal, real, and proper Disease, is of such consequence, that a Physician can make no rational Judgment without it. 'Tis this capacity and skill of reasoning from the Symptoms to the internal, original, and proper Disease, that distinguishes a true Physician from a Quack or ignorant Pretender, and that renders his Judgment preferable to that of a Nurse, a Midwife, or a Country Farmer, who might chance by Recipes to cure a Jaundice, or any other Disease, without knowing what it is, or from whence its Symptoms arise.*

I HAVE instanced here in a Jaundice, as being a popular Disease and commonly known; but what has been said may be equally apply'd to a Fever, a Dropsy, or any other Disease, as I hope to evince in some of the following Propositions. 'Tis therefore a right knowledge of the Animal Machine, and a just reasoning thereupon, from Effects to their Causes, from the outward sensible Appearances to their internal and more remote Originals, Sources, or Fountains, that can alone qualify a Physician to make such Judgments of Diseases as must secure his Success, and justify his Practice.

BUT the word Cauſe, *as apply'd to Diſeaſes, is ſometimes taken for the antecedent Occaſions by which they are brought on, ſuch as Over-heating, taking Cold, bad Air or Diet, immoderate Evacuations, violent Paſſions, or any exceſs in the Nonnaturals; all which may help a Phyſician to form a right Judgment concerning the original morbid Conſtitution, or the Diſeaſe it ſelf: but as the ſame antecedent occaſional Cauſes produce different Effects at different Times, and in different Conſtitutions; ſo 'tis the Symptoms alone, or ſenſible Appearances of the Diſeaſes that can certainly be depended on in this Caſe.*

THE Diſeaſe being thus known, or found out from the Symptoms, and conſequently the proper Indications of Cure; the next Inquiry is after the Remedy, or ſuch Medicines as will moſt effectually anſwer the general Indications: and this is what can only be known by Experience, and can never be obtain'd by any Method of Reaſoning à priore. *No chymical Tortures, microſcopial Inſpections, or other Methods of Trial without Experience, could ever have inform'd us of the Powers and Propertys of Medicines, or what Effects they will produce within us.*

WHO could ever have imagin'd, if Experience had not confirm'd it, that bliſtering with Cantharides, *which abound with ſuch an extremely pungent active and cauſtick*

Oyl

Oyl and Salt, would ſo powerfully cool and dilute the Blood in Fevers? Who could ever have known, but by actual Experience of its Effects, that the Bark would ſo effectually, beyond any thing elſe, correct the Errors of Concoction, or prevail ſo exceedingly in intermitting or remitting Fevers, and in almoſt all periodical Diſeaſes?

THE different Effects of Mercury Sublimate and Calomel, could never have been found out by any chymical Analyſis, or upon the Principles of the Corpuſcularian Philoſophy. And the like may be ſaid of any other Subſtances with regard to their different Effects upon the animal Organs and Fluids; their peculiar Efficacy could never have been found out à priore, *and can only be known by Uſe and Experience.*

THE Poiſon of the Viper indeed diſcovers ſome odd Phænomena when view'd thro a Microſcope; but there are many other things perfectly innocent, which give us either the very ſame, or altogether as formidable an Appearance.

NOTHING but Uſe and Experience could have inform'd us, that Opium will ſo gratefully affect the Nerves as to procure Sleep, eaſe Pain, and ſtop a Diarrhæa; that Saffron will ſo effectually heat, attenuate, and rarefy; that black Hellebore will ſo powerfully cool, attenuate, depreſs, and condenſe the Blood; and that Mercury has ſuch a prodigious Efficacy in diſſolving and

diſ-

discussing the Tumors and Concretions of the Glands.

IN short, the peculiar sensible Qualitys and Effects of Bodys, depend on a certain particular Texture and Cohesion of their minute invisible Parts, which are as much unknown to us as the different Arangement of Particles upon the Surfaces of Bodys, or the differently modify'd Vibrations of elastick Bodys, upon which the various Refrangibility of Light, and the variously modify'd Undulations of the Air depend, and from which the different and respective Ideas of Colours and Sounds are excited in the Mind.

HERE therefore, where we cannot come at the necessary Data, *philosophizing is trifling; and they who in such Cases affect Eloquence and Ostentation, may amuse and surprize the Vulgar, while they will certainly expose themselves to the just Ridicule and Contempt of the truly Learned.*

THESE, I think, are the proper and distinct provinces and boundarys of Theory *and* Experience *in the Practice of Medicine. 'Tis from the Knowledge of the animal Oeconomy only, or the Laws and Principles of Motion in the animal Machine, that the Disease can be found out by a rational Deduction from the Symptoms: and from hence alone can the general Indications of Cure be taken. For he who is ignorant of the Disease, or the real internal State of the Organs and Fluids in which the Disease consists,*

siſts, can never form any rational Judgment of the moſt proper Methods of Cure.

ANY one by a little reading, may eaſily inform himſelf of the real or reputed Powers, Virtues, and Propertys of Medicines, ſo far as the Experience of others have been committed to writing, and reduced to general Rules; but this is the leaſt part of a Phyſician, and he who only knows thus much, knows only how to act at random and to do miſchief. Every Apothecary (or even his Man at a Year's ſtanding) may be acquainted with the ſeveral Claſſes of Medicines made up by him, or ſold in his Shop; he may be well vers'd in the ſeveral Tribes of Simples and Compounds, and be ſufficiently acquainted with the ſeveral Claſſes of Catharticks, Emeticks, Sudorificks, Diureticks, &c. and yet be no better a Phyſician than his Horſe. 'Tis one thing to know how to bleed, purge, vomit, &c. and a quite different thing to know when, and under what particular Circumſtances either the one or the other of theſe is to be choſen; how far to be allow'd, and when or by what means to be moderated and reſtrain'd. The former may be got by reading, or learned by rote; but the latter can only be obtain'd by a juſt acquaintance with that part of natural Philoſophy which reſpects the animal Oeconomy.

PARTICULAR Rules, grounded upon Experience, and laid down in Books for all the variety of Caſes, complications of

Symp-

Symptoms, and continually fresh arising Incidents in Practice, are impossible; but the Reason of things is always the same: and a seasonable varying the Method, as the various Symptoms arise, and according to the different State and Gradations of the Disease, is that in which the Physician discovers his principal Judgment and Skill.

SINCE the Powers and Propertys of Medicines, or the Effects they are capable of producing within us, can be only known by Use and Experience; a faithful account of these, grounded upon just Observation, and a long continu'd impartial Trial, must certainly be a matter of the utmost Consequence, and is plainly a Debt due to Mankind. And yet after the Experience of so many Ages, there is nothing even at this Day, more uncertain or precarious than the Materia Medica. *Among the vast number of simple and compound Remedys, recommended under great Names, and celebrated with lofty Encomiums, when a Man comes to make an impartial Trial for himself, he will find but very few of them that can be much depended on: For such have been either the Rashness or Credulity of those who have undertaken to give us the Virtues and Propertys of Medicines, that for the most part, any great Expectation raised upon them, serves only to delude the Hopes of the Patient for a time, and finally to disgrace the Physician. And from hence, doubtless,*

it

it came about, that the Practice grew more uncertain, and leſs ſucceſsful in proportion to the bulk of the Materia Medica, *and the numerous new Recipes and Remedys added continually from time to time, to the multitude of uſeleſs ones before.*

'TIS true, indeed, that the Materia Medica *has of late been very much reduc'd, and a great many precious Trifles and celebrated empyrical Specificks have been laugh'd at and thrown out; but ſtill perhaps the greater part of what remains may deſerve the ſame Fate: for it muſt be own'd, that the peculiar and diſtinct Virtues of Simples, have been never yet ſubjected to a ſufficient ſcrutiny, or eſtabliſh'd upon any ſuch experimental Authority, as might be capable of ſupporting their common Reputation. Every experienc'd Phyſician muſt know, that the Qualitys of Simples are generally deliver'd with ſuch great confuſion and uncertainty, that not one in forty will anſwer the Character they bear; and that many things are ſtill cry'd up for a thouſand divine Virtues, which are ſcarcely endu'd with any one good Property; inſomuch that a young Phyſician at his firſt ſetting out, has not ſo much as a fair Chance for it, whether his Expectations from the many celebrated Preſcriptions and boaſted Remedys he will meet with, ſhall be well or ill grounded.*

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FROM this generality, indistinctness, and confusion of Ideas about the Virtues of Simples, not sufficiently establish'd upon any honest impartial Experience, arose doubtless the humour of compounding Medicines with so much trouble and to so little purpose; while the main bulk of the Composition is often made up of things useless, if not hurtful, and contrary to the general Intention, and the only efficacy confin'd to a very few of the Ingredients, which bear but a small proportion to the rest. But this, I think, is certain, that when a Disease is well understood, the Cure, so far as it can be effected at all, will depend upon a very few Remedys, and those of the plainest and most simple Composition. And there cannot perhaps be a surer mark of a Novice or Ignoramus *in his Profession, if he be not something worse, than the affectation of a multiplicity of pompous Ingredients in almost every thing that is given: by which the Doctor seems to prescribe more for the Apothecary than for the Patient; instead of a Course of Medicine sends in a Course of pharmaceutick Diet; and loads the Files with Bills, that might at a little distance be mistaken for Deeds of Conveyance and Court-Rolls: But this certainly is a great Evil under the Sun, which* Solomon, *had it happen'd in his Days, must have taken particular notice of, since nothing can be better entitled to the Censure of* Vanity and vexation of Spirit.

EVERY one, I think, who has any just concern for the Health and Happiness of Mankind, must reckon himself oblig'd to contribute what he can towards the removing or preventing this Mischief, so far as it depends on that generality, indistinctness, and confusion, in which the Materia Medica *for the most part still lies: to which purpose, if a sufficient number of able, impartial, and well-experienc'd Physicians would but once undertake to give us in a faithful Account of the Powers and Propertys of Medicines, (especially the most simple and uncompounded) under the several particular Cases and Intentions of Cure in which they have most constantly and regularly observ'd their good Effects; this would doubtless be the most effectual way of establishing a more rational, safe, and generally successful Practice, and of disgracing and throwing out that remaining superfluity, and useless load of officinal Lumber, which is still retain'd under the Name of Medicines, to the great Detriment of the Publick, and defeated Hopes of Valetudinarians.*

I AM clearly persuaded, that abstracting from Diet, the Medicines which are capable of answering any great Intentions of Cure among the animal and vegetable Substances are very few, and might easily be reduc'd to such a number, under their manifest and sensible Operations, as neither to overload the Memory nor confound the Judgment.

VE-

VEGETABLE and animal Specificks I know are abundantly cry'd up in great Numbers, even in the moſt obſtinately fix'd, glandular, and chronick Caſes; but it might eaſily be demonſtrated, that they cannot poſſibly effect what is pretended of them, nor in the leaſt come up to the ſeveral Intentions for which they are recommended: and whenever any ſuch Cure is ſuppoſed to be done by them, the Phyſician may well cry out, O Patient, great is thy Faith!

THE Chymiſts indeed, finding Mercury in many Caſes to be a great Remedy, thought by torturing it into a thouſand different Appearances, and mixing it with all other ſorts of mineral Subſtances, to have obtain'd from it at laſt ſome abſolute infallible Catholicon for the Cure of all Diſeaſes, and ſo to have made it a happy Succedaneum *to the* Tree of Life: *but after all theſe fiery Trials, upon a thing that Nature has provided to relieve Mankind under ſome of the greateſt exigencys of Diſeaſe, perhaps the plaineſt, ſimpleſt, and mildeſt Preparations of Mercury are ſtill the beſt; and by ſuch time as the Conveniencys and Inconveniencys of its rougher and more operoſe Preparations are well balanc'd, I doubt not but this Obſervation will be ſufficiently juſtify'd.*

THIS Ignorance, Impudence, Enthuſiaſm, and empyrical Oſtentation of the old Chymiſts, is doubtleſs equall'd, if not much out-done, by the numerous Tribe of modern

Quacks, that swarm up and down in every part of the City and Country, with their boasted Catholicons and Specificks; and who, while they pretend to certain universal Remedys, capable of curing all Diseases, by rectifying all the irregular Motions of the Blood, cleansing off all the obstructing Viscidity's and Concretions in the Glands, and reducing the Solids and Fluids to their natural and due state of Action; take Money at the same time for an infinite number of appropriated Medicines, peculiar to every particular Disease or prevailing Symptom. Thus the Catholicon, which does every thing at once and in general, gives way to the Specifick which is brought in upon every particular occasion, to do what had been as effectually done before. And thus the Quack, who is all things in general, and every particular thing by turns, appears to be nothing else but an empty vain Pretender.

WHETHER the Word Specifick, *as used in Medicine, has any fix'd determin'd meaning, is hardly perhaps worth while to enquire; but this I think is certain, That there cannot be a truer mark of a Cheat in his Profession, than of one who crys up any thing as a universal Remedy, or makes great Pretensions to a multitude of* Nostrums, Arcana, *and Specificks of his own.*

THE original distinct morbifick Constitutions are not very numerous, and may easily be reduced to a few general Heads; and

the primary Medicines of any great, remarkable, and distinct Efficacy, as they are plain, simple, and uncompounded, so perhaps they are not much more numerous than the original morbifick Constitutions themselves.

NOW where any particular morbid Constitution exists distinctly, and is not mix'd or complicated with any other, some primary simple Medicine of peculiar Efficacy under that Constitution, such as Nature has prepar'd, will suffice for the Cure, and any farther artificial Pomp or Apparatus *would be needless.*

BUT because the originally distinct Constitutions of Diseases, are for the most part complicated, and apt to unite with and run into one another, so as to form a compound Disease; in this case, the different Complication of the Disease, *which can be known only by the present circumstantial Differences in the* Appearances *and* Symptoms, *must determine the Nature, Quality, and different Proportions of the compound Remedys. And such are the different Complications of Diseases, and the different Species and Modifications of the Symptoms in particular Cases, that the same precise Composition of a Disease is scarce ever to be found in two Persons alike, or in the same Person at different Times. And this shews the necessity of a rational extemporaneous Practice, in which the compound medicinal Course must be suited to the complicated Disease,*

as judged of by the present circumstantial Appearances and Symptoms; and at the same time evinces the impossibility of obtaining this great end of Practice by any fix'd and stated Prescriptions, or canonical Compounds.

NATURE indeed always acts upon a few plain and simple Principles; but these are so infinitely diversify'd in her particular Operations, as not to be reducible to any certain determinate number of general Rules, but must be understood and apply'd by a Method of right reasoning from Effects to their Causes, in which every Man must make his own Rules and Canons of Practice for particular Cases, as he has a present Occasion for them.

THIS is evidently so in Arithmetick, Geometry, Mechanicks, and every other Subject which is mix'd, and made up of Theory and Practice: And this, in the Case before us, must ever distinguish a Man of Judgment and Skill in his Profession, from all others who may pretend to what they understand not, or have no Genius for.

THIS Method of reasoning is excellently exemplify'd in the Newtonian Philosophy; *where by first evincing Gravity, as universal in fact, and then applying that general Principle to the several Phænomena of Nature, a vast number of particular Appearances, which were before inexplicable, are plainly and demonstratively accounted for.*

I HAVE therefore employ'd the first Part *of this Work upon the Method of eſtabliſhing the Principle of Gravity as univerſal in fact, and applying it to ſome of the principal Phænomena of Nature; not only as it is of ſome conſequence in the Subject I am writing about, and has accordingly been touch'd upon already by a Gentleman very conſiderable, and juſtly celebrated in his Profeſſion; but chiefly as it is the beſt Specimen and Exemplar that could be given of the general Method of right reaſoning in all other Caſes, and particularly in the Theory and Practice of Medicine.*

I N the ſecond Part *I have endeavour'd to fix and aſcertain the general Morbifick Conſtitutions; to ſhew what are their peculiar Symptoms, and how they may be variouſly mix'd and complicated with each other; that the Complication of Symptoms being known, the compound Diſeaſe might be found out. And I have here added ſo many* Corollarys *and* Scholia *with reſpect to Practice, as to anticipate in great meaſure what I at firſt intended for the* third *and* laſt Part, *which therefore will be found very ſhort. But to compenſate farther for this, I hope for an opportunity ſome time or other to publiſh ſomething more particular upon the Practice, as grounded upon the Principles here laid down.*

I AM sorry that my other Affairs, and my state of Health, should have kept my Friends so long in Expectation till they are impatient of the Delay; but having at length finish'd what I intended, I shall be very glad if the general Opinion be not alter'd, and the Publication now at last thought too soon. I am sensible how extremely difficult it is to write a good Theory of Diseases, and how impossible to satisfy those, who have already strongly imbib'd and retain'd a different or contrary Scheme of Principles: but notwithstanding the difficulty of writing well upon the Subject, I comfort my self however with this, that 'tis almost as difficult to write worse than others have done before me. And therefore with such sufficient Authority, and in so much good Company, it will be indifferent to me whether what may be thought amiss in this Performance, be imputed either to the Difficulty of the Subject, or to the Incapacity of the Author. I speak not this with any such mere Indifferency, as if I had resolv'd to give up the Principles I have here advanc'd, without a just Defence upon a proper occasion. Such a Disposition would be unworthy of a Man who pretends to any Concern for Truth, or Service to the Publick: and therefore, whatever may be fairly objected from Reason or Experience, I shall think my self oblig'd to consider and reply to. But if any one who plainly dis-

covers himself to be unacquainted with the Philosophy of Nature, and the History of Diseases, shall think fit to become my Adversary from Spite, Envy, or Ostentation; I shall revenge upon him only by silence, sit still as easy and unconcern'd as if no such thing had happen'd, and leave the Book against any such feeble Opposition to shift for it self.

Marlborough,
May 20. 1725.

T. Morgan.

TO

TO

Dr. *MORGAN*,

ON HIS

Philoſophical Principles of Medicine.

DISTINGUISH'D Worth demands the Poet's [Lays,
Accept this grateful Tribute to your Praiſe.
Great is the Task, extenſive is the Theme,
Great as your Work, extenſive as your Fame:
Yet the bold *Muſe* attempts the vaſt Deſign,
And your Applauſe ſhall ſwell in every Line.

IN the primæval happy Days of old,
When *golden Years* their ſhining Circles roll'd,
When on wild Fruits and Herbs they liv'd content,
And thankful took what Heav'ns rich Bounty ſent;

No noxious Humors ſtain'd their crimſon Flood,
And what is *Phyſick* now, was then their *Food*:
They bloom'd in youth at threeſcore Years and ten,
For *Nature* was the ſole Phyſician then.

DISEASE, at firſt, ſprung from her Parent *Vice*,
And hence the *healing Art* deriv'd its riſe:
Bleſt Art! whoſe Power diſpels our Pain, and ſaves
From pining Sickneſs, and devouring Graves.
Plain Remedys, at firſt, were valu'd moſt,
The Drugs were few, and moderate the Coſt;
The Sick were cur'd without a gilded Pill,
A ſovereign Bolus, or a pompous Bill.
As Vice increas'd, ſo *Phyſick* by degrees
Increas'd its Empire, and increas'd its Fees.

IN after-times it more myſterious grew,
As *Pride* prevail'd, and *Intereſt* came in view,
Dreſs'd by deſigning Men in dark diſguiſe,
And veil'd in awful Shapes from vulgar Eyes.

WITH GALEN's Sect a cloud of Med'cines came,
Of various Form and venerable Name;
Phyſick was all Confuſion, all profound,
While Jargon reign'd, and Learning lay in Sound;
Till the laſt Age appear'd, when Gleams of Light
Dart thro the Chaos, and diſpel the Night.

THEN BACON flouriſh'd, in whoſe ſpacious Soul
Unnumber'd Truths in beauteous order roll.

THEN ſhone the learned, the induſtrious BOYLE
And ſought out Truth with an unweary'd toil;
BOYLE on Experiment alone rely'd,
And Nature, which he lov'd, was ſtill his guide.

LOCKE now like ſome propitious Star appears,
And his *fair Fabrick* of *Ideas* rears,
Which all the Schoolmens Sophiſtry diſplay'd,
And welcome Light to every Art convey'd.

SYDENHAM then made the way to Practice plain,
Taught by no idle Fictions of the Brain;

SYDEN-

SYDENHAM the old, the ſimple way renew'd,
Nor ſtudy'd what was *Great*, but what was *Good*.
He reſcu'd Phyſick from its uſeleſs load,
And pointed out a more ſucceſsful road.

THE Scene ſtill brightens each revolving Year,
And lo! freſh Wonders to our view appear;
Lo! *Medicine* ſhines with *Mathematick* Rays,
The welcome *Omen* of *propitious* Days:
Such was of late the pleaſing vaſt ſurprize,
When *Northern Streamers* lighted all the Skies;
When ſoon, as ſhades of Night the Earth o'erſpread,
Amaz'd we ſaw *new Morning* o'er our head.
Charm'd with the Tidings, many a *learned Sage*
Does eager in the great Deſign engage;
While new Diſcoverys their Reſearches crown,
Give Health to others, to themſelves Renown.

BUT tho ſuch numbers have purſu'd the Theme,
To *You* alone we owe a *finiſh'd Scheme*:
All that BELLINI, or that PITCAIRN dar'd,
At beſt is faint Eſſay with *Yours* compar'd;

The

The *Method* clear, each Part with Judgment [wrought,
Enrich'd with *labour'd Skill*, and *depth of Thought*.

THE learn'd BOERHAVE will hail the grate- [ful Sight,
And read you o'er with *wonder* and *delight*.
While the *fam'd Tribe* you treat with ſuch regard,
Who beſt can judge of Worth, and beſt reward;
The Man they love with juſt Applauſe extoll,
And in their *ſhining rank* your Name enroll.

THUS the *vaſt Genius* is at length reveal'd,
Which long, too long, in darkneſs lay conceal'd;
Thro interpoſing Clouds it makes its way,
And breaks, refulgent with celeſtial Day.
So Gems diſclos'd in ſome *Peruvian Mine*,
With innate Fire, and rugged Luſtre ſhine.
Great Souls blaze out with their own native Light,
Tho Fortune frown, and Envy wrecks her ſpight.
You leave the beaten Circle of the Schools,
And the dull Round of antiquated Rules:
On *obvious Facts* your *Principles* depend,
All to ſupport our tottering Fabrick tend;

While,

While, by *juſt Conſequence*, from theſe you draw
Some *fundamental Truth* and *uſeful Law*,
To guard Man's feeble Frame from fell Diſeaſe;
Or, when we ſink with Pain, to give us Eaſe:
To every Ail aſcribe its proper Cauſe;
For Nature's govern'd by *Mechanick Laws*.
With niceſt Skill you paint her outward dreſs,
In vain we'd penetrate the deep Receſs;
No human Eye her ſecret Springs can trace,
But loſt in Mazes, leaves the fruitleſs chace.
Mount Ætna thus conceals her unknown Fires,
And *rapid Nile* to hidden paths retires.

SAGES now truſt to Fairy Scenes no more,
Nor venture farther than they ſee the Shore:
They build on *Senſe*, then *reaſon from th' Effect*,
On well eſtabliſh'd *Facts* their Schemes erect;
By theſe ſome new *Phænomena* explain:
Thus they proceed, and *Truth Divine* obtain.

SUCH was the Path *immortal* NEWTON trod,
He form'd the wondrous Plan, and mark'd the Road;

Led

Led by this Clue, he travell'd o'er the Sky,
And marshall'd all the *shining Worlds* on high,
Pursu'd the *Comets* where they fartheſt run,
And brought them back obſequious to the Sun.

MEN may on Fancy's airy Pinions riſe,
And in Imagination touch the Skies;
Be pleas'd with Theorys becauſe they're new,
And then for being pleas'd believe them true:
On Nature call, but call, alas! in vain,
To foſter all the Monſters of their Brain.
Nature has no imaginary Schemes,
No vain Chimeras, nor romantick Dreams;
She offers *Truth*, not *Fiction* to the Mind,
Nor makes us fancy what we never find.

MATURE *in Thought*, you NEWTON's *Laws* [reduce
To nobler Ends and more important Uſe.
You ſhow how heav'nly Orbs affect our *Frame*,
And raiſe, or ſink by turns the *vital Flame*:
How *Moons alternate*, in their changing Sphere,
Impreſs their Force, and agitate the Air;

How

How as without ſucceſſive Tides advance,
While the pale Moon purſues her ſilent dance;
So does the *refluent Blood* her Influence know,
And Tides within *roll high*, or creep on ſlow.

WHEN *raging Fevers* kindle Flames within,
Which dreadful glow o'er all the ſcorch'd *Machine*;
You ſhew how Nature grows averſe to Food,
And pants for Liquors to dilute the Blood;
Shuts up the Pores, and prudently detains
The flowing Serum in the burning Veins.
Your *gentle Med'cines* mitigate the Heat,
And cool the Blood, without expence of Sweat:
The Monſter *Febris* flies the mighty Spell,
In haſte retires, and calmly ſeeks her Cell.

SO when the *ſultry Dog-ſtar* reigns on high,
And all the Fountains of the Earth are dry;
When parched Fields look withering all around,
And frequent Chaſms divide the thirſty Ground;
Indulgent Heav'n bids numerous Vapors riſe,
And lo! th' obedient Vapors croud the Skies;

While

While bursting Clouds descend in Show'rs of rain,
Revive the Plants, and cool the burning Plain.

MED'CINE from hence shall boast of sure Success,
Nor *Patients* long remain without redress,
But raise, from Scenes of Death, their drooping Heads,
And flusht with sudden Life forsake their Beds.

FOR this shall future Ages sound your *Fame*,
And distant Climates echo with your Name:
Your *Work* it self will its Admirers *raise*,
And Men that breathe by you, shall breathe your Praise.

MY raptur'd *Muse* sees with *prophetick* Eyes,
New Ages roll along, new Nations rise;
Sees *Physick* on *Mechanick Reasoning* climb,
And raise a Structure to the Skies sublime;
Sees Sickness fled, Health bloom in every Face,
And Age creep on with slow, reluctant Pace.
Experience with her Torch shall guide our Youth,
Scatter the Mists, and light the way to *Truth*.

While

While dark Hypotheſis no more prevails,
Nor *Pupils* liſten to romantick Tales;
Nor proud Authority, with bugbear Rules,
Controuls the *Church*, nor dictates in the *Schools*.
But *Liberty* ſits Goddeſs of our *Iſle*,
And peaceful Bleſſings all around her ſmile;
Darkneſs and Bigotry before her fly,
And *Truth* and *Virtue* grow beneath her Eye.

October 10. 1724. Sam. Bowden.

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PROP.

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PROP. XV. *There is in all Bodys, and the several Parts of which they are compos'd, a mutual Attraction, Gravitation, or* Conatus mutuo accedendi; *which Force is of the same nature and kind with that which we call* GRAVITY *or* Weight, *by which Bodys tend to the Centre of the Earth; and is ever in a Ratio compounded of the Quantitys of Matter in the Bodys themselves directly, and the Squares of their Distances reciprocally.* p. 28

PROP. XVI. *The absolute central Forces, or Quantitys of Matter in attracting Bodys, are universally*

in the triplicate Ratio of the Distances of revolving Bodys from those Centres directly, and the duplicate Ratio of the periodical Times inversly: that is, those Forces, or Quantitys of Matter, are ever as the Cubes of the Distances, divided by the Squares of the periodical Times. p. 34

PROP. XVII. *The Densitys of all central attracting Bodys, are ever in the compound reciprocal Ratio of the Cubes of the Parallaxes of the Bodys revolving about them, multiply'd into the Squares of their respective periodical Times.* p. 35

PROP. XVIII. *If a Body, as* P, *revolves about another Body* S; *that other will likewise revolve about the former; that is, they will both revolve in the same Time about their common Centre of Gravity: And the Figures described about the common Centre of Gravity, and about each other mutually, will be respectively similar.* p. 41

PROP. XIX. *If two Bodys* S *and* P, *attract or tend to each other mutually, with given Forces, and at the same time revolve about the common Centre of Gravity* C; *I say, that with the same Figures thus described about the common Centre of Gravity, a similar and equal Figure may be describ'd with the same Forces, by either of those Bodys about the other consider'd as immoveable.* p. 42

PROP. XX. *If two Bodys attracting each other mutually, revolve about their common Centre of Gravity, the Distances remaining the same; the periodical Time about the Centre of Gravity, is to the periodical Time of one of those Bodys revolving about the other, by the sole Attraction of that other, in the subduplicate Ratio of the fix'd or central Body to the Sum of the Bodys.* p. 44

PROP. XXI. *The same things supposed as in the last Proposition; I say, that the periodical Times being equal, the Distance of the Bodys revolving about*

about their common Centre of Gravity, is to the Distance of the same Bodys, where one of them revolves about the other considered as immoveable, in the subtriplicate Ratio of the Sum of the Bodys to the fix'd or central Body. p. 45

PROP. XXII. *If a Body revolving about a given Centre, has its Motion disturb'd by the Attraction of some other Body drawing it to a different Centre; 'tis requir'd to find the general Laws and Proportions of the perturbating Forces.* p. 47

PROP. XXIII. *If a Corpuscle be placed within a Concave Sphere, whose Surface consists of Parts attracting each other mutually, in the reciprocal duplicate Ratio of their Distances; the said Corpuscle thus placed any where within the Concavity, will not be attracted at all, but every where remain in a state of Rest or Æquilibrio.* p. 57

PROP. XXIV. *The Time in which a Body let fall from any given Altitude within the Surface, would come to the Centre of the Earth, and ascend again to the same Altitude on the other Side; that is, the whole Time of such an Oscillation, as supposed in the foregoing Corollary, is equal to the semi-periodical Time of a Body revolving about the Earth, at the Distance of one Semidiameter, and retain'd in its Orbit by the sole Force of Gravity, such as it obtains at the Earth's Surface.* p. 60

PROP. XXV. *The Time in which a Pendulum of any given Length will perform its Vibration, is equal to the semi-periodical Time of a Body revolving by the Force of Gravity in an Orbit, whose Radius or Semidiameter is equal to the Length of the Pendulum.* p. 61

PROP. XXVI. *The Space thro which a heavy Body will descend perpendicularly, during the Time that a given Pendulum performs its Vibration, is to half the Length of the Pendulum, in the duplicate Ratio*

of the Circumference to the Diameter. p. 63

PROP. XXVII. *If a large Sphere or Globe, such as the Earth, be made to revolve about its Axis while it is in a state of Fluidity, it will by such a Motion acquire the form of an oblate Spheroid; in which the Proportion of its Axis to its æquatorial Diameter, will be as the Length of a Pendulum vibrating Seconds at the Æquator, to the Length of a Pendulum vibrating in the same Time at the Poles.* p. 65

PROP. XXVIII. *Supposing the same as in the last Proposition; the Augmentations of Gravity, in going from the Æquator to the Poles, will be in the duplicate Ratio of the Lines of the Latitude.* p. 67

PROP. XXIX. *The Earth by the Rotation about its Axis, is reduc'd to an oblate Spheroid, whose Axis, or polar Diameter, is to the Diameter of the Æquator nearly as* 124 *to* 125. p. 69

PROP. XXX. *To find the perturbating Forces of the Sun and Moon, upon the Ocean and Atmosphere.* p. 70

PROP. XXXI. *All the physical sensible Effects that can proceed from such a Cause of Attraction, and Perturbation of Motion in our Ocean and Atmosphere, must be owing to the Sun and Moon; and all the other Planets and Fix'd Stars are wholly to be rejected, and left out of the Account in the present Case.* p. 77

PROP. XXXII. *What has been hitherto demonstrated, concerning the perturbating Forces of the Sun and Moon upon the Ocean, in producing the alternate Flux and Reflux of the Waters, must be consequently understood also of the Atmosphere, in which the same Perturbations of Motion must likewise happen.* p. 79

PROP. XXXIII. *These Perturbations of the Ocean and Atmosphere must necessarily be impress'd upon the Blood and animal Fluids, and produce very sensible and*

and considerable Effects in animal Bodys. p. 80

PROP. XXXIV. *Besides the general Force of Gravity, or the Weight of Bodys, as explain'd and apply'd in the foregoing Propositions, the very small Particles of Matter, which constitute the larger Masses, are endu'd with a strong attractive Force, which exerts it self only at, or extremely near the Points of Contact; and vanishes at any greater Distance: Which Force or Power of Attraction, to distinguish it from that of Gravity, may be call'd the Force of* COHESION; *it being that Force by which the small Parts of Bodys unite and cohere among themselves.* p. 86

PROP. XXXV. *Elementary Fire and Air act and re-act mutually upon each other: that is, the Air is expanded and rarefy'd by Heat, which is the Action of Fire; and Fire is excited and put into its most violent and rapid Motion, by the Expansion of the Air.* p. 94

PROP. XXXVI. *The attractive cohesive Power of the small Parts of Matter, as explain'd at* Prop. 34. *is the universal Principle of Rest, Concretion, and Fixation in Bodys; and the expansive Force of heated Air, or the mutual conjunct Action of Fire and Air, as in the last* Proposition, *is the universal Principle or natural Cause of Fermentation, Dissolution, and Fluidity.* p. 97

PROP. XXXVII. *The expansive or centrifugal Force of heated rarefy'd Air, separates and dissolves the Parts of solid Bodys; and intimately mixes and blends together the Parts of Fluids, so as to hinder the separation of their heterogeneous Particles.* p. 108

PART II.

Laws of the Motion and Secretion of the Vital Fluids.

PROPOSITION I. *The Blood-Globules are specifically heavier than the Serum, and consist of Particles, which*

which are endu'd with a ſtronger corpuſcular Attraction, and which receive and retain a greater degree of Heat. p. 111

PROP. II. *The* Craſſamentum, *or globular Part of the Blood, is a ſtanding or fix'd Quantity; and is not at all increas'd or diminiſh'd by the Augmentation or Diminution of the glandular Secretions.* p. 118

PROP. III. *To find the abſolute and relative Velocity of the Blood.* p. 121

PROP. IV. *Muſcular Motion is perform'd by the intrinſick Elaſticity of the nervous* Fibrillæ, *contracting and reſtoring themſelves againſt the ſtretching Force of the circulating Blood.* p. 124

PROP. V. *The Nerves are repleniſh'd with a ſoft oily Liquor, not much unlike the White of an Egg; ſerving to cool, moiſten, and lubricate the nervous elaſtick Fibres.* p. 140

PROP. VI. *The Lungs are a Muſcle, in which the Air performs the ſame Office with the Blood in other Muſcles.* p. 142

PROP. VII. *To explain the Flux and Reflux of the Vital Fluid, or the occaſional Elevation and Depreſſion of the Blood.* p. 154

PROP. VIII. *To explain the Nature and Uſe of animal Secretion.* p. 166

PROP. IX. *The continual Paſſage of the Blood thro the ſmall capillary Arterys, and of the Serum thro the minute glandular* Tubuli, *is the great Principle of Attenuation in the Animal Oeconomy, by which the Blood and animal Fluids have their Parts moſt minutely broken, ſeparated, and kept from coagulating, or running into large concreted Maſſes.* p. 186

PROP. X. *The expurgatory Secretions are augmented by Watching and Exerciſe, and diminiſh'd by Sleep and Reſt: but on the contrary, the lymphatick Secretions are increaſed by Sleep and Reſt, and leſſen'd by Watching and Exerciſe.* p. 188

PROP.

PROP. XI. *The lymphatick circulatory Secretions, by Sleep are increaſed in a greater Proportion than that in which the Evacuations, or expurgatory Secretions are diminiſh'd.* p. 192

PROP. XII. *The Urine which is brought continually into the Bladder, is derived partly from the Stomach it ſelf immediately by direct Paſſages, and partly from the ſecretory Ducts of the emulgent Arterys, by which it is ſtrain'd from the Blood thro the Kidneys.* p. 193

PROP. XIII. *To explain the Origin, Formation, and Conſtitution of glandular Diſeaſes.* p. 195

PROP. XIV. *To explain the Origination and eſſential Conſtitution of* Fevers *in general.* p. 206

PROP. XV. *To aſſign the moſt general and remarkable Specifications, Forces, and Appearances of Fevers.* p. 244

PROP. XVI. *To explain the natural Order, and the ſeveral morbifick Irregularitys of Digeſtion.* p. 318

PROP. XVII. *To explain the natural Phænomenon of Sleep, with the Effects of Opium, and ſuch-like ſoporiferous Drugs.* p. 335

PROP. XVIII. *To explain the Origination and Mechaniſm of the* PASSIONS, *with regard to their different Modifications, and Impreſſions of Pleaſure and Pain.* p. 365

PART III.

Primary Intentions of Medicine in the Cure of Diſeaſes.

PROPOSITION I. *To explain the morbifick Conſtitutions, as depending on the different State and Diſpoſition of the Blood.* p. 397

PROP. II. *To cool, dilute, and attenuate the Blood.* p. 411

PROP. III. *To retain the* Æquilibrium *of the circulating Blood, againſt the frequent occaſional*

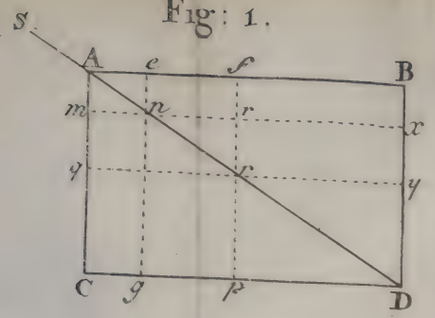
Affluxes and Refluxes of the vital Fluid. p. 429
PROP. IV. *To recover and maintain an equal or due Proportion of the* Craſſamentum *and Serum in the Blood.* p. 431
PROP. V. *To ſtrengthen and keep up the elaſtick Tone, or muſcular Force of the Nerves.* p. 434
PROP. VI. *To promote and keep up the Natural Evacuation or Secretion by Urine.* p. 437

ERRATA.

Preface, Page ix. Line 3. for *unanimated* read *animated*. P. 67. l. 11. and p. 69. l. 2. for *Lines* r. *Sines*. P. 73. l. 15. for 9 or $\frac{9}{7}$ r. 90 *gr.* P. 180. l. 31. for *Aortæ* r. *Portæ*. *Coroll.* 2. of *Prop.* 30. *Part* I. is ſupernumerary, having been inſerted by Miſtake.

Philo-

Fig: 1.



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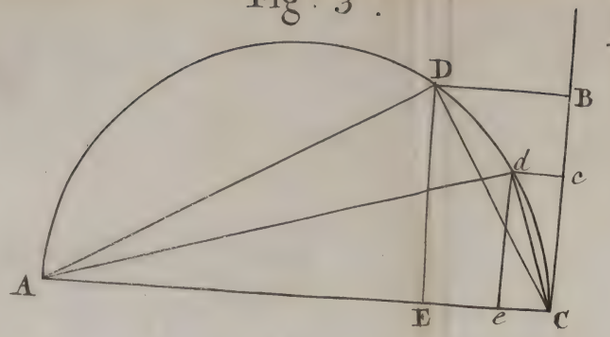

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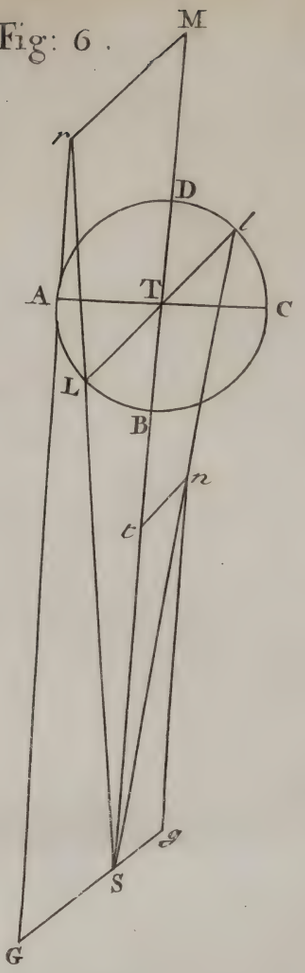

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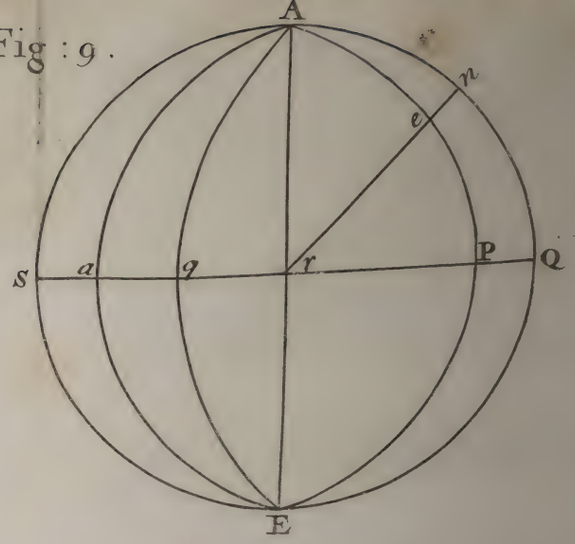

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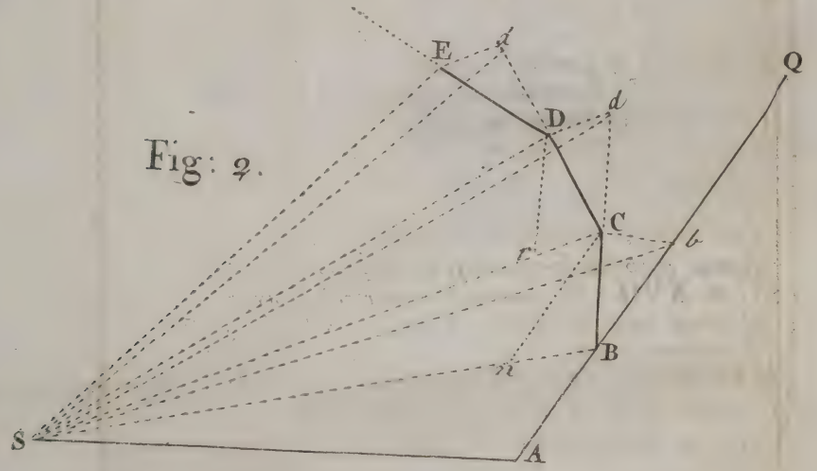

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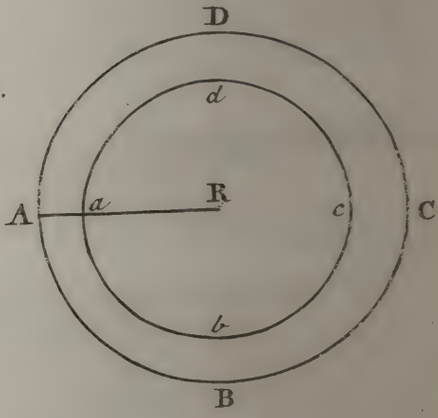

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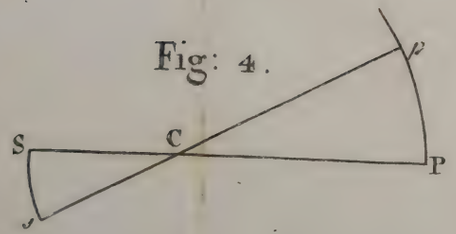

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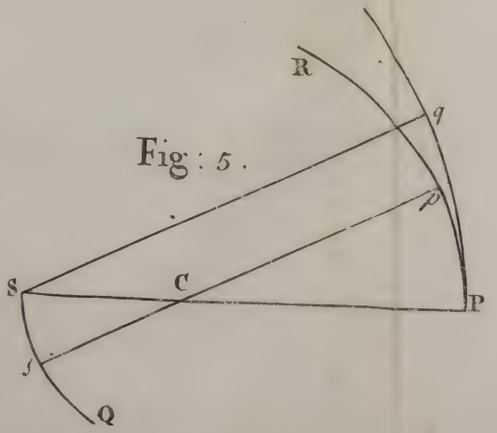

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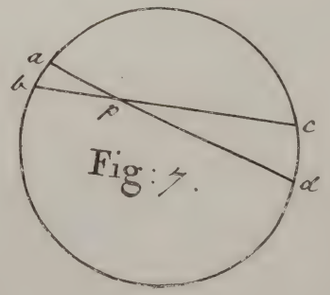

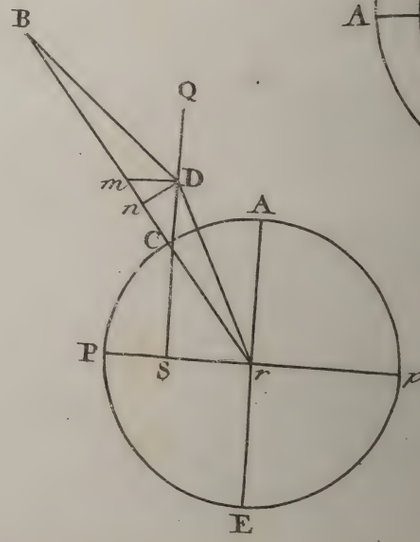

Fig: 10.

Philoſophical Principles OF MEDICINE.

PART I.

Containing a Demonſtration of the general Laws of Gravity; with their Effects upon Animal Bodys.

LAWS *of* MOTION.

Law 1. ALL Bodys will for ever continue in their State of Reſt, or uniform direct Motion, unleſs they are compell'd to change that State by ſome external impreſs'd Force.

Law 2. THE Alteration of Motion is ever proportional to, and in the same given Direction with the impress'd Force that causes it.

Law 3. RE-ACTION is ever equal, and contrary to Action; or the mutual Actions of any two Bodys upon each other are always equal, and in contrary Directions.

PROPOSITION I.

THE Quantitys of Motion, or vires motrices *in all moving Bodys, are, as the Quantitys of Matter and Velocitys conjunctly.*

FOR if the Velocitys are equal, 'tis manifest that the Quantitys of Motion, or moving Forces will be as the Quantitys of Matter; and if the Quantitys of Matter are equal, the Motions will be as the Velocitys; therefore universally, the Quantitys of Motion are in the compound Ratio of both, or as the Quantitys of Matter multiply'd into the Velocitys.

PROPOSITION II.

IN all moving Bodys, the Spaces describ'd are as the Velocitys multiply'd into the Times of their Description.

FOR

FOR the Velocitys being equal, the Spaces deſcrib'd muſt be as the Times; and the Times being equal, the Spaces are as the Velocitys: therefore univerſally, the Spaces deſcrib'd will be in the Ratio compounded of the Times and Velocitys.

PROPOSITION III.

A BODY will deſcribe the Diagonal of a Parallelogram by two ſeveral Forces combin'd, in the ſame time that it would have deſcrib'd one or the other of its Sides, by one or the other of theſe two Forces, ſeparately and reſpectively.

IN the Parallelogram ABCD *Fig.* 1. Suppoſe a Body at A would deſcribe the Line AC, with an equable Velocity, as M in the Time T: and the ſame Line AC, moving together with the Body, always parallel to it ſelf, and to BD, would, with a like uniform Velocity as N, deſcribe the Parallelogram ABCD, in the ſame Time T. 'Tis manifeſt that the Velocity as M, in the Direction AC, and the Velocity as N, in the Direction AB, will be as thoſe Lines of Direction AC and AB reſpectively. Draw the prick'd Lines *mx* and *qy*, parallel to AB; and *eg* and *fp* parallel to AC: becauſe of the Parallelism, the Triangles ACD, A*qr*,

and A*mn* will be similar; and therefore AC: CD:: A*q*: *qr*:: A*m*: *mn*. And consequently, while the Body with the Velocity, as M, is carry'd from A to *m*, the Line AC, with the Velocity as N, will be translated into the Position *eg*, and the Body will be in the Diagonal at *n*; and when the Line AC comes to the Position *fp*, the Body in the Direction AC, will have describ'd the Space A*q*=*fr*, and will be found at the Point *r* in the same Diagonal: and by the same Necessity, when the Line AC coincides with BD, the Body by its own proper Motion will have describ'd the Space AC=BD, and will be found at D; that is, it will describe the Diagonal by both these Forces conjunctly, in the same Time that it would have describ'd one or the other of these Sides, by one or the other of these Forces separately and respectively: Which was the thing to be prov'd.

COROLLARY I.

From hence 'tis plain, that the Forces by which the Sides and Diagonal of a Parallelogram are describ'd, are proportional to, and may consequently be expounded by those Sides, and that Diagonal respectively.

COROLLARY II.

From hence it likewise follows, that if a Body be held immovable by two equal Forces in contrary Directions, acting from A to D, and

and from A to S, it is the ſame thing as if it was held immovable by three Forces in the Directions AB, AC, and AS; becauſe the Forces AB and AC are by the Propoſition equivalent to, and will produce the ſame Effect with the Force AD, or AS: and conſequently one may be ſubſtituted in the room, or uſed inſtead of the other.

COROLLARY III.

FROM hence 'tis farther evident, that if a Body be held immovable by three Powers, thoſe Powers are one to another directly, as the Lines that are drawn parallel to their reſpective Directions, and terminated at the Points of their mutual Concourſe. For by *Coroll.* 1. the Powers acting in the Directions AD, AB, AC, are proportional to thoſe Lines AD, AB, AC, reſpectively; that is, as the Lines parallel to the Directions, and terminated at their common Interſection.

PROPOSITION IV.

IF a Body be continually urg'd or impell'd by any given Force, acting upon it inceſſantly and without Intermiſſion, the Motion thence ariſing will be uniformly accelerated; in which Caſe the Velocitys will be ever as the Times, and the Spaces deſcribed as the Squares of the Times, or the Squares of the reſpective Velocitys.

A BODY at reſt being put into motion by one ſingle Impulſe, it will, abating external Reſiſtance, continue to move on in a Right Line, and with an uniform Velocity proportional to, and in the ſame given Direction with the impreſs'd Force, by *Law* 2. But where Motion is communicated not by one ſingle Impulſe, but by a continued impreſſion of an equal uniform Force without intermiſſion, the Force impreſs'd will be as the Times; that is, double in a double Time, triple in a triple Time, *&c.* But the Motion communicated, and the Velocitys thence ariſing, are proportional, by the ſame *Law* 2. and conſequently, the Velocitys, in this Caſe, will be equably and uniformly accelerated in proportion to the Times: But the Spaces deſcribed, are ever in a Ratio compounded of the Times and Velocitys, by *Prop.* 2. And therefore, where the Ratio of the Times and Velocitys is the ſame, or where the Velocitys are proportional to the Times, as in the preſent Caſe, the compound Ratio of the Times and Velocitys, will be the ſame with the Squares of the Times, or the Squares of the Velocitys reſpectively: Which was the thing to be proved.

COROL-

COROLLARY.

HENCE it follows, that if a Body moves uniformly, with the whole Velocity acquir'd by an accelerated Motion in a given Time, it would deſcribe twice the Space in the ſame Time, or an equal Space in the ſame Time, with half that Velocity. For in an accelerated Motion, where the Velocitys flow uniformly with the Times, if the Time be expounded by the Perpendicular of a Right-angled Triangle, the Baſe will rightly expound the Velocity; and the Area of the Triangle, the Space deſcribed. Thus in the Triangle ACD, *Fig.* 1. if AC expound any whole Time of an accelerated Motion, CD will repreſent the Velocity acquir'd in that Time; and the Triangle ACD, the Space deſcribed. And if A*m*, A*q*, AC, are put for the different Times, *mn*, *qr*, CD, will be as their different and reſpective Velocitys; and the Triangles A*mn*, A*qr*, ACD, as the Spaces deſcrib'd. But if in the whole Times, A*m*, A*q*, AC, the Body ſhould move uniformly with the whole Velocitys *mn*, *qr*, CD, it would deſcribe the Parallelograms A*mne*, A*qrf*, ACDB, which are double the Triangles, A*mn*, A*qr*, ACD; that is, in the ſame Time that a Body with an accelerated Motion deſcribes a given Space, it will deſcribe double that Space with an uniform, conſtant Velocity, equal to that which was laſt acquir'd by the Accelera-

tion; and consequently, an equal Space in the same Time, with half that Velocity.

PROPOSITION V.

THE Gravity or Weight of Bodys is an accelerating Force; and this Gravity or Weight at the Surface, or at equal Distances from the Centre of the Earth, is directly proportional to the Quantitys of Matter contain'd in such Bodys.

THAT Bodys press continually, or tend equally and uniformly to the Centre of the Earth, and consequently, that this Gravity or Weight is an equably accelerated Force, is evident to Sense, as a most undoubted Matter of Fact; and it likewise farther appears, from the most accurate Observations and Experiments,

First, THAT the accelerating Velocitys, acquir'd by Bodys in their perpendicular Descent, reckoning from the Beginning of their Motion, are ever as the Times in which they are acquired; and the Spaces described, as the Squares of the Times.

Secondly, THAT abstracting from the Resistance of the Air, the Space describ'd by the perpendicular Descent of a Body in one Second of Time, is equal to 16,1 *English* Feet; and for any longer or shorter Time, as the Squares of those Times respectively.

Thirdly,

Thirdly, THAT the Reſiſtance of the Air being taken off, or allow'd for, the accelerating Velocitys of all Bodys near the Earth's Surface, are exactly equal; the lighteſt Bodys deſcending as ſwift as the heavieſt, and the leaſt as ſwift as the greateſt: the different Magnitudes, Denſitys, and particular Figures, Textures, and Conſtitutions of Bodys, making no manner of difference as to their Velocitys of Deſcent; which in all Bodys alike are ever equal in equal Times, and proportional to the Squares of thoſe Times. Now ſince the *Momenta* or Quantitys of Motion, in Bodys whoſe Velocitys are equal, are as their Quantitys of Matter, by *Prop.* I. and ſince the accelerating Velocitys of all Bodys, deſcending by the ſole Force of their own Weight, are likewiſe equal, by what has been juſt now obſerv'd; 'tis evident, that the abſolute *Momenta*, or Quantitys of Motion in all ſuch Bodys, are likewiſe as their Quantitys of Matter: But theſe *Momenta*, or abſolute Forces of deſcending Bodys, are nothing elſe but their abſolute Gravitys, by which they preſs continually, or tend equally and without Intermiſſion to the Centre of the Earth: And therefore, this abſolute Force of Gravity or Weight in Bodys, is exactly proportional to their Quantitys of Matter.

COROL-

COROLLARY.

FROM hence it follows, that there are Vacuitys or empty Spaces in Bodys. For ſince in conſequence of this Propoſition, the Weight of Bodys is proportional to their Quantitys of Matter; and ſince upon the Suppoſition of an abſolute *Plenum*, the Denſitys of all Bodys muſt be equal, or an equal Quantity of Matter every where contain'd in equal Spaces; 'tis evident, that upon this Hypotheſis, the Weight of Bodys muſt be ever proportional to their Bulk or Magnitude, and there could be no difference of Specifick Gravity in Bodys; which being moſt notoriouſly contrary to Fact, muſt evidently and demonſtratively overthrow that Hypotheſis of an abſolute *Plenum*, upon which it is founded.

PROPOSITION VI.

IF a Body moving with an equable Velocity in a given Direction, be at the ſame Time continually and equally impell'd, drawn, or any ways urg'd to a given Point, without the Line of its uniform Direction; the ſaid Body, by the Compoſition of theſe two Motions, will deſcribe a Curve about the given Point of its Central Force; in which the Areas deſcrib'd by Lines drawn from the Centre, will be ſituated in the ſame Plane, and ever proportional to the Times of Deſcription.

Fig.

Fig. 2. SUPPOSE a Body at A, moving with an uniform Velocity in the Line, or with the Direction A Q, to be continually drawn, impell'd, or ſome way or other urg'd to the Centre S; 'tis evident, that abſtracting from the Force towards S, the Body with the uniform Velocity in the Direction A Q, would deſcribe the equal Spaces A B, B *b*, &c. in equal Times; and that if it moves the Space A B in the firſt equal Portion of Time, it would in the ſecond equal Portion of Time deſcribe the Space B *b* = A B. But let us now ſuppoſe the Force towards S to exert it ſelf, not inceſſantly, but by ſtarts and intervals, at the end of ſmall equal Portions of Time; and ſince the Body acted only by the ſingle Impulſe in the Direction A Q, would at the end of the ſecond Particle of Time be tranſlated to *b*; let the centripetal Force towards S, be now imagin'd to draw the Body from *b* to C; let *b* C be drawn parallel to S B, and C *n* parallel to B *b*, completing the Parallelogram, C *n* B *b*: And ſuppoſe the ſame thing to be done for the third equal Portion of Time, and ſo on, as long as the Motion is continued. Now in the Parallelogram C *n* B *b*, 'tis plain that the Side B *b* expounds the Motion of the Body in its uniform Direction, ariſing from the firſt ſingle Impulſe, which is ſuppoſed to be continued without Reſiſtance; and the Line *b* C, repreſents the Motion of the Body, as

it

it is continually accelerated towards the Centre S: But by *Prop.* 3. a Body acted upon by two distinct Forces B*b* and *b*C, which are to each other as the Sides of a Parallelogram, will describe the Diagonal BC. Likewise, in the third equal Particle of Time, while the Body by its innate uniform Motion would describe the Line C*d*; and by its renewed Motion towards the Centre, the Line *d*D; it will by the Composition of these Forces describe the Diagonal CD, *&c.* Now that the Polygon SABCD, *&c.* is concave towards S, and that it lies in the fix'd or immovable Plane SAQ, is very evident from the Construction; and that the Triangles SAB, SBC, SCD, *&c.* are equal, may be thus proved: The Triangles SBA, and SB*b* are equal, as having equal Bases, and the same common Altitude; and the Triangle SB*b* is equal to SBC, as standing on the same Base SB, and lying between the Parallels C*b* and *n*B: therefore, the Triangle SBC is equal to SAB. And in the same manner, the Triangle SCD may be proved equal to SCB, *&c.* that is, the Areas describ'd are equal in equal Times, and consequently always proportional to the Times of their Description. Let now the Times be lessened, and the number of the Sides AB, BC, CD, *&c.* increas'd *in Infinitum*, and let the centripetal Force towards S, be suppos'd to act not by Starts and small Intervals, but incessantly and without Intermission, and

then

then the Polygon S A B C D E, *&c.* will be a Curve, concave towards S, and lying in the ſame given Plane S A Q, in which the Areas will be ever proportional to the Times of Deſcription.

COROLLARY.

HENCE, if the Areas deſcrib'd by revolving Bodys about a given Point are proportional to the Times, it muſt follow; That the Point given is the true Centre of Force to which the ſaid revolving Bodys are drawn, impell'd or urg'd, and by which they are retain'd in their Orbit, and kept from flying off in Right Lines. Thus in the ſame *Fig.* 2. if it be found that the Triangles S A B, S B C, are equal, 'tis evident that C *b* muſt be parallel to S B, and conſequently that the Force C *b*, or the centripetal Force, is directed to the Point S.

PROPOSITION VII.

IF a Body revolves in a circular Orbit about the Centre, the centripetal Force generated in a given Time will be ever equal to the Square of the Arch deſcrib'd in the Time given, divided by the Diameter of the Circle.

IN *Fig.* 3. The Triangles A *d* C and *d e* C are ſimilar, by 8 *Eucl.* 6. Let A C the Diameter be call'd *d*, C *d* the Chord *c*, and C *e* the verſed

verſed Sine v. Then it will be $d : c :: c : v$; therefore $dv = c^2$, and $v = \frac{c^2}{d}$. If another Arch be taken, as D C, and its Chord call'd C, its verſed Sine V, and the Diameter as before d; it will be by the ſame Reaſoning $V = \frac{C^2}{d}$. and 'tis evident that the Caſe muſt be the ſame univerſally, whether in the ſame or different Circles; that is, the verſed Sine of an Arch will be ever equal to the Square of the Chord of that Arch, divided by the Diameter of the Circle. Now if we ſuppoſe the Arches D C, d C, to be infinitely ſmall, 'tis manifeſt that in that Caſe, the Chords will coincide with the Arches themſelves, and may be reckoned the ſame; and in this Caſe the verſed Sines, or Subtenſes of the Angles of Contact, C E = B D, and C e = c d, will expound the centripetal Forces, or accelerated Motion towards the Centre; and conſequently, what has been demonſtrated of the Chords, will hold good of the Arches, in this their firſt ariſing or laſt vaniſhing State: That is, the infinitely ſmall Accelerations of the centripetal Forces, will be equal to the infinitely ſmall Arches, divided by the Diameters. But ſince the Areas deſcribed by all revolving Bodys are as the Times, by the laſt Propoſition; and ſince in a Circle equal Areas muſt have equal Arches, therefore in this Caſe, the Arches

will

will be deſcrib'd uniformly as the Times; and the central accelerating Forces are ever as the Squares of the Times, by *Prop.* 4. and conſequently as the Squares of the Arches. Therefore, what has been prov'd of the infinitely ſmall Naſcent or Evaneſcent Arches, muſt likewiſe hold univerſally and eternally of all Arches in this caſe of circular Motion: that is, the centripetal Forces generated in a given Time will be ever equal to the Squares of the Arches divided by the Diameters: Which was to be demonſtrated.

PROPOSITION VIII.

IF two or more Bodys revolve about a central Body, their centripetal Forces, or accelerating Velocitys towards the Centre, will be ever in a Ratio compounded of the Diſtances directly, and the Squares of the periodical Times reciprocally: that is, theſe Forces will be as the Radii or Diſtances, divided by the Squares of the periodical Times.

LET the greater Radius or Diſtance be call'd R, and the leſſer *r*; the Arch deſcrib'd in the greater A, in the leſſer *a*; the centripetal Force at the greater Diſtance C, at the leſſer *c*; the reſpective periodical Times P, and *p*; and let the Ratio between the Circumference and Diameter be *e*: then will 2 R *e* be the greater Circumference, and 2 *r e* the leſſer; and in conſequence of what has been

been demonstrated in the last Proposition, $\frac{A^2}{2R} = C$, and $\frac{a^2}{2r} = c$, therefore $A^2 = 2RC$, and $A = \overline{2RC}^{\frac{1}{2}}$: and for the same Reason $a = \overline{2rc}^{\frac{1}{2}}$. Now 'tis evident that the Circumference divided by the Arch describ'd in a given Time will be equal to the whole periodical Time, taken in Parts of the same Denomination with those, which the said Arch is supposed to be describ'd in; and therefore $\frac{2Re}{A} = P$, and $\frac{2re}{a} = p$. But $\overline{2RC}^{\frac{1}{2}} = A$, and $\overline{2rc}^{\frac{1}{2}} = a$, by what has been already proved: Therefore, by substituting $\overline{2RC}^{\frac{1}{2}}$ for A, and $\overline{2rc}^{\frac{1}{2}}$ for a; it will be $\frac{2Re}{\overline{2RC}^{\frac{1}{2}}} = P$, and $\frac{2re}{\overline{2rc}^{\frac{1}{2}}} = p$; and squaring the last Equations, it will stand thus $\frac{2Re^2}{C} = P^2$ and $\frac{2re^2}{c} = p^2$; therefore $\frac{2Re^2}{P^2} = C$, and $\frac{2re^2}{p^2} = c$; consequently $\frac{2Re^2}{P^2} : \frac{2re^2}{p^2} :: C : c$. And dividing by $2e^2$, $\frac{R}{P^2} : \frac{r}{p^2} :: C : c$, or $Rp^2 : rP^2 :: C : c$; That is, the centripetal Forces are in the compound Ratio of the Radii or Distances directly, and the Squares

of

of the periodical Times reciprocally; or as the Distances divided by the Squares of the periodical Times.

PROPOSITION IX.

FROM the Law of the periodical Times given, to find the Law of the centripetal Force universally.

IN consequence of what has been demonstrated in the last Proposition, and to avoid the repetition of the different Symbols, we may say in general, that the centripetal Force is ever as $\frac{r}{p^2}$; from which general expression, if the Law of the periodical Times with respect to the Distances be given, by substituting that general Ratio in the room of p^2, the Ratio, or general Law of the centripetal Force, will presently appear.

THUS in the first place, if the periodical Times are equal, the Ratio of p^2 will be a Ratio of equality; and $\frac{r}{p^2}$ will be equivalent to $\frac{r}{1}$: that is,

THEOREM I.

IF the periodical Times are equal, the centripetal Forces will be as the Radii directly.

IF the Squares of the periodical Times are as the square Roots of the Distances; by substituting $r^{\frac{1}{2}}$ for p^2, the Ratio $\frac{r}{p^2}$ will be

equivalent to $\frac{r}{r^{\frac{1}{2}}}$ or $r^{\frac{1}{2}}$: that is,

THEOREM II.

If the Squares of the periodical Times are as the square Roots of the Distances, the centripetal Forces will be in the same subduplicate Ratio of the Distances.

If the Squares of the periodical Times are as the Distances, then substituting r for p^2, the Ratio $\frac{r}{p^2}$ will be the same with $\frac{r}{r}$, which is a Ratio of equality. Therefore,

THEOREM III.

When the Squares of the periodical Times are as the Distances, the centripetal Forces will be equal.

If the periodical Times are as the Squares of the Distances, and consequently the Squares of the periodical Times in the biquadratick Ratio of the Distances; in this case putting r^4 for p^2, the Ratio $\frac{r}{p^2}$ will be the same with $\frac{r}{r^4}$, or $\frac{1}{r^3}$; that is,

THEOREM IV.

Where the periodical Times are as the Squares of the Distances, the centripetal Forces will be in the inverse triplicate Ratio

of thoſe Diſtances, or as the Cubes of the Diſtances reciprocally.

BUT if the Squares of the periodical Times are as the Cubes of the Diſtances, by ſubſtituting r^3 for p^2, the Ratio $\frac{r}{p^2}$ will be expreſs'd by $\frac{r}{r^3}$; that is, $\frac{1}{r^2}$: *i. e.*

THEOREM V.

WHEN the Squares of the periodical Times are as the Cubes of the Diſtances, the centripetal Forces or accelerating Velocitys towards the Centre, will be as the Squares of the Diſtances reciprocally.

AND thus may the ſame Principle, or general Law, be apply'd univerſally to any particular Caſe, to diſcover the Law of the centripetal Force, from the Law of the periodical Time given.

PROPOSITION X.

THE Velocitys of Bodys revolving about a given Centre at different diſtances, are univerſally as the Diſtances directly, and the periodical Times reciprocally; or, which is the ſame thing, directly as the Radii divided by the periodical Times.

FOR if the periodical Times are equal, the Velocitys will be as the Radii or Diſtances; that is, as the Peripheries, which are the

Spaces deſcribed. But if the Diſtances are equal, 'tis plain that the Velocitys muſt be reciprocally as the periodical Times: Therefore univerſally, the Velocitys will be in the Ratio compounded of both theſe; that is, the Diſtances directly, and the periodical Times inverſly, or as the Diſtances divided by the periodical Times.

SCHOLIUM I.

SINCE in conſequence of this Propoſition the Velocitys are ever as $\frac{r}{p}$, where r ſtands for Radius or Diſtance, and p for periodical Time; we have hereby a general Canon to determine the Ratio of the Velocitys, from the Law of the periodical Times given, as has been done with reſpect to the centripetal Forces at *Prop.* 9. Thus ſuppoſe the Squares of the periodical Times to be as the Cubes of the Diſtances, and conſequently the periodical Times themſelves in the ſeſquialterate Ratio of the Diſtances, or as $r^{\frac{3}{2}}$; then in the general expreſſion for the Velocity $\frac{r}{p}$ in the place of p, ſubſtituting its equivalent $r^{\frac{3}{2}}$, it will be $\frac{r}{r^{\frac{3}{2}}}$ or $\frac{1}{r^{\frac{1}{2}}}$: that is, where the periodical Times are in the ſeſquialterate of the Diſtances, the Velocitys will be as the ſquare Roots of the Diſtances reciprocally.

SCHO-

SCHOLIUM II.

WHAT has been ſaid here about Velocitys and centripetal Forces, compar'd with the Diſtances, muſt be underſtood of the middle Diſtances and mean Velocitys, where the Bodys revolve not in circular but in elliptical Orbits, about one of the Foci. 'Tis commonly known that every Ellipſis is equal to a Circle, whoſe Diameter is a mean Proportional between the tranſverſe and conjugate Diameters; at which diſtance, a Body moving in an Ellipſis obtains its mean Velocity, and would perform its revolution in the ſame Time as before: From whence 'tis plain, that what is demonſtrated of Bodys moving in Circles, concerning the Laws and Proportions of their Velocitys, periodical Times and centripetal Forces, muſt hold good alſo in Ellipſes, with reſpect to theſe mean Diſtances.

PROPOSITION XI.

THE primary Planets revolve about the Sun, the Moon about the Earth, and the Satellites of Saturn *and* Jupiter *about* Saturn *and* Jupiter, *as their true and proper Centres: And the Law of their Revolution is ſuch, that the Squares of their periodical Times are as the Cubes of the Diſtances from their different and reſpective Centres.*

THIS Propoſition is matter of Fact and Experience; and therefore it will be a ſufficient demonſtration of it, to ſet down here the periodical Times and proportional Diſtances, as they are obſerv'd and computed by the beſt modern Aſtronomers.

THE periodical Times of the primary Planets about the Sun, and their proportional Diſtances from the Sun's Centre, are as follows:

		d.	*h.*	′			
SATURN	revolves about the SUN in the Space of	10759	06	36	Proportional diſtances from the Centre of the SUN,		953806
JUPITER		4332	12	20			520116
MARS		686	23	27			152399
The EARTH		365	06	09			100000
VENUS		224	16	49			72333
MERCURY		87	23	16			38710

SATURN has five Satellites or ſecondary Planets revolving about him, whoſe periodical Times and proportional Diſtances are thus determined:

		d.	*h.*	′	″		
The firſt	revolves in the ſpace of	1	21	18	26	Proportional Diſtances,	181
the ſecond		2	17	41	10		231
the third		4	12	25	10		323
the fourth		15	22	41	28		749
the fifth		79	07	46	00		2182

THE four Satellites of *Jupiter* revolve about him in the periodical Times, and at the proportional Diſtances following:

		d.	*h.*	′	″		
The firſt	revolves in the ſpace of	1	18	27	36	Propor. D.	292
the ſecond		3	13	13	42		454
the third		7	3	42	36		725
the fourth		16	16	32	09		1276

THE

THE Moon revolves about the Earth at the mean Diſtance of 60 of the Earth's Semidiameters; each Semidiameter containing 3984 *Engliſh* ſtatute miles.

NOW whoever will compare the proportional Diſtances with the reſpective periodical Times, will find that the Times are every where in the ſeſquialterate Ratio of the Diſtances; which demonſtrates the truth of the Propoſition.

SCHOLIUM.

THE foregoing proportional Parts are all taken upon the ſame Scale, and are to be underſtood of ſuch parts, of which the Diſtance of the Earth from the Sun contains 100000. But the reduction of theſe to any known aſſignable meaſure, depends upon the Sun's Parallax, or the Angle which the Semidiameter of the Earth would ſubtend to an Eye at the Centre of the Sun: and according to the beſt and moſt accurate Obſervations hitherto made, by comparing the Parallax of the Earth with that of *Mars* and *Venus*; this parallactick Angle of the Sun at the Earth is about 11″; with which Meaſure of the Sun's Parallax, as coming very near the truth, we may reſt ſatisfy'd, till ſome more favourable Phænomenon hereafter ſhall give the Aſtronomers an opportunity of determining this matter, to the greateſt nicety and exactneſs.

Now the Parallax being taken as here 11″, each of the foregoing proportional parts will contain 747 *Engliſh* ſtatute miles: and therefore, if thoſe proportional Diſtances are reſpectively multiply'd by 747, they will be reduced to ſuch miles. Likewiſe the Semidiameter of the Earth contains $5\frac{1}{3}$ of ſuch proportional parts: and conſequently, if thoſe proportional Diſtances are ſingly and reſpectively divided by $5\frac{1}{3}$, they will be reduced to Semidiameters of the Earth.

And becauſe the middle Diſtance of the Moon from the Earth, is 60 of the Earth's Semidiameters, and each Semidiameter contains $5\frac{1}{3}$ of the aforeſaid proportional parts; therefore the Diſtance of the Moon from the Earth is 320 ſuch proportional parts, of which the Diſtance of the Earth from the Sun contains 100000.

PROPOSITION XII.

LET two or more Bodys be ſuppoſed to revolve about the Earth at different Diſtances, and to be retain'd in their Orbits by their Weight, or accelerating Forces towards the Earth's Centre; and I ſay, that the Law of their Revolution will be ſuch, that the periodical Times will be in the ſeſquialterate Ratio of the Diſtances; or the Squares of the one, as the Cubes of the other.

THE Earth having but one ſingle Satellite or ſecondary Planet, the Moon revolving about her, we cannot here compare the Motions of any two Bodys actually revolving and reſpecting the Centre of the Earth, as has been done with reſpect to the *Sun*, *Saturn*, and *Jupiter*. But ſince we know in fact, that the accelerating Velocity of all Bodys near the Earth's ſurface, is after the rate of 16,1 *Engliſh* feet in the firſt Second of Time; it will be eaſy from hence to determine the periodical Time of a Body revolving near the ſurface, or at the diſtance of one ſemidiameter, and retain'd in its Orbit by this common acceleration towards the Centre: To which purpoſe; let r ſtand for the Radius or Semidiameter of the Earth, $2re$ for the Circumference, c for the accelerating Velocity at the ſurface 16,1 Feet, and p for the periodical Time. Then by what has been demonſtrated at *Prop.* 8. it will be $\frac{2re^2}{c} = p^2$; that is, the Circumference of the Earth in Feet, multiply'd by the Ratio between the Circumference and Diameter, and divided by 16,1, the accelerating Velocity generated in one Second, will give the Square of the periodical Time in Seconds: from which extracting the ſquare Root, and dividing by 60, we ſhall have the periodical Time in Minutes. From this computation, the periodical Time of a Body

thus

thus revolving, will be found = $84\frac{2}{3}$ minutes nearly.

Now the Moon, at the distance of 60 semidiameters, revolves about the Earth in the space of 39343 minutes. But $84\frac{2}{3}$ and 39343, are in the sesquialterate Ratio of the Distances 1 and 60; or the Squares of the one, as the Cubes of the other: Which was the thing to be proved.

PROPOSITION XIII.

THE centripetal Forces, or accelerating Velocitys of the Moon to the Earth, of the primary Planets to the Sun, and of the Satellites of Saturn *and* Jupiter, *to* Saturn *and* Jupiter *respectively; are universally in the reciprocal duplicate Ratio of the Distances from their different and respective Centres.*

For the Squares of the periodical Times are ever as the Cubes of the Distances, by the two last Propositions; but where the Squares of the periodical Times are as the Cubes of the Distances, the centripetal Forces will be as the Squares of the Distances inversly, by *Prop. 9. Theorem* 5; and therefore the centripetal Forces or accelerating Velocitys of those revolving Bodys, towards their proper and respective Centres, must be ever in the reciprocal duplicate Ratio of the Distances, or as the Squares of the Distances inversly.

PRO-

PROPOSITION XIV.

THE accelerating Velocitys of any two Bodys towards each other, are reciprocally as the Bodys themſelves, or directly as the Quantitys of Matter in the attracting Bodys to which the acceleration is made.

SUPPOSE two Bodys, A and B, mutually attracted by, or gravitating towards each other; and let *a* expreſs the accelerating Velocity of A towards B, and *b* the accelerating Velocity of B towards A. Now Re-action being ever equal and contrary to Action, 'tis evident that the *Momentum motus* of A towards B, muſt be equal to the *Momentum motus* of B towards A; that is, A *a* = B *b*: But the *Momenta* of Bodys, are univerſally as the Quantitys of Matter multiply'd into the Velocitys, by *Prop.* 1. therefore, if *a* and *b* expreſs the Velocitys, A and B will expound the Quantitys of Matter reſpectively. And becauſe A *a* = B *b*; therefore, A : B : : *b* : *a*; and A : *b* : : B : *a*: That is, the Quantity of Matter in A, is to the Quantity of Matter in B, as the accelerating Velocity of B towards A, to the accelerating Velocity of A towards B.

COROLLARY.

FROM hence it follows, that at equal diſtances, the Quantitys of Matter in all Bodys conſidered as central and attracting, are as

the

the accelerating Velocitys towards them. For in this Propoſition, the diſtance of B from A, and of A from B, is the ſame; and the Quantitys of Matter are as the accelerating Velocitys towards thoſe Bodys directly: But by *Prop.* 13. the accelerating Velocitys of all Bodys towards the ſame Centre, are equal at equal Diſtances; therefore the Quantitys of Matter in all Bodys, are as the accelerating Velocitys towards them, where the Diſtances are equal.

PROPOSITION XV.

THERE is in all Bodys, and the ſeveral Parts of which they are compoſed, a mutual Attraction, Gravitation, or Conatus mutuò accedendi; *which Force is of the ſame nature and kind with that which we call* GRAVITY *or* Weight, *by which Bodys tend to the Centre of the Earth; and is ever in a Ratio compounded of the Quantitys of Matter in the Bodys themſelves directly, and the Squares of their Diſtances reciprocally.*

THAT theſe attracting or gravitating Forces at the ſame or equal Diſtances, are as the Quantitys of Matter in the Bodys themſelves, has been proved in the laſt Propoſition; and with reſpect to the ſame central or attractive Body, the centripetal Forces are as the Squares of the Diſtances reciprocally, by *Prop.* 13. Therefore univerſally,

thoſe Forces muſt be in a Ratio compounded of both theſe, or as the Quantitys of Matter directly, and the Squares of the Diſtances reciprocally. Now that this Force is univerſal, and equally affects the Sun, the Earth, the Moon, and all the primary and ſecondary Planets, is evident from what has been hitherto demonſtrated: But ſince the Weight of Bodys here with us, is an accelerating Force; and at the Earth's ſurface, or equal Diſtances from the Centre, as the Quantitys of Matter in the Bodys themſelves, by *Prop.* 5. and ſince alſo the periodical Time of a Body revolving about the Earth, at the Diſtance of one Semidiameter, and retain'd in its Orbit by its own Gravity or Weight, would be to the periodical Time of the Moon revolving likewiſe about the Earth, in the ſeſquialterate Ratio of the Diſtances, by *Prop.* 12. which is the ſame Law that has been prov'd to obtain, with reſpect to the primary Planets about the Sun, and the Satellites of *Saturn* and *Jupiter* about their primary ones: 'tis plain from hence, that this Force is of the ſame nature and kind with the Gravity or Weight of Bodys, obtaining univerſally throughout the whole Solar Syſtem, and acting according to the general Law which has been here demonſtrated.

COROL.

COROLLARY.

FROM hence it follows, that the Earth revolves, as a Planet, annually about the Sun; and conſequently, that the Sun remains fix'd, as the true and proper Centre of the whole Syſtem. For,

SUPPOSING the Earth to revolve about the Sun, its periodical Time and Diſtance will exactly correſpond to the Length of our ſolar Year, according to the general Law of Nature, by *Prop.* 11. that is, the periodical Time of the Earth, compared with thoſe of the other primary Planets, will be preciſely in the ſeſquialterate Ratio of the Diſtances. But if the Sun revolves by its gravitation to the Earth as its Centre, as the Moon moſt certainly does; the periodical Time muſt be 413 times greater than it now is, and the ſolar Year in that caſe muſt contain 413 of our preſent ſolar Years: that is, ſuppoſing the Sun's Parallax to be 11 ſeconds; which agrees to the beſt Obſervations. But if the Sun upon this Hypotheſis be brought ſo near the Earth, as to make the preſent ſolar Year agree to the periodical Time of the Moon, with reſpect to the Earth as their Centre; the Sun's Parallax in this caſe muſt be increaſed to about 10 minutes: whereas all Obſervation aſſures us, that it cannot exceed the fourth part of a minute. So that the Reſt of the Sun in the Centre of the whole Syſtem, and the annual Motion of the Earth, is now

no

no longer an Hypotheſis, but a matter of Demonſtration.

SCHOLIUM.

It muſt be here obſerved, to prevent the miſtakes that ſome have run into, that theſe Terms, *Attraction* and *Gravitation*, are not intended to expreſs either the abſolute Nature, or phyſical Cauſe of the Forces themſelves; but only the Quantity and Direction of the Motion generated and produced by them. 'Tis certain fact, that Gravity, whether we conſider it at the ſurface of the Earth, or any where elſe, is an accelerating Force capable of producing a given Quantity of Motion, in a given Time, according to the general Law; which has been demonſtrated in this Propoſition. And this muſt neceſſarily hold good, whatever the abſolute Nature or phyſical Cauſe of Gravity be. Some people pretending to Philoſophy, not adverting to this, have blunder'd moſt egregiouſly in their Objections againſt the *Newtonian* Principles; as if the Cauſes of Motion there aſſign'd, were impoſſible, abſurd, and unintelligible. Theſe Objections are mainly grounded upon an imagination, that the illuſtrious Author ſuppoſes the Gravity or Weight of Bodys to be an eſſential and intrinſick Power or Property in the Bodys themſelves; or the mere reſult of Matter acting upon Matter: whereas he ever ſuppoſes,

poſes, and frequently in expreſs terms declares the contrary.

But I hope theſe mechanical Gentlemen, who ſeem unwilling to admit any thing but Matter and Motion in the World, will not therefore renounce their Senſes, and deny that there is any ſuch Force in Nature, as the Weight of Bodys; becauſe they find themſelves at a loſs perhaps, in aſſigning the Origination and phyſical Cauſe of this Force.

The wonderful and incomparable Author of the *Principia*, has at leaſt given as good an account of the cauſe of Gravity as any body elſe; and therefore, if the caſe ſhould be ſuch, that it could not be fairly accounted for at all, it muſt be very unreaſonable to charge this, as a peculiar difficulty on the *Newtonian* Philoſophy. For whether Gravity be an eſſential intrinſick Property of the Bodys themſelves, or the neceſſary Effect of Matter acting upon Matter; or laſtly, the Action of ſome intelligent Cauſe: yet ſtill the *Newtonian* Philoſophy muſt hold good, and may be ſupported upon either of theſe Suppoſitions; ſince this Philoſophy only aſſumes upon demonſtration, this power, or principle of Gravity, as univerſal in fact, and from thence demonſtratively accounts for the actual Phænomena of Nature.

Those who cannot agree with the great Author, that the Gravity or Weight of Bodys is a Force impreſs'd upon the whole material Syſtem, and continually exerted

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in one conſtant uniform Law, by the firſt Cauſe, or God himſelf; are at liberty, no doubt, to account for the Cauſes of Things without a firſt Cauſe, as well as they can.

But then they muſt either come in fine to a firſt Cauſe, or elſe run their accounts *in infinitum*, and ſuppoſe every thing to be Effect, without Cauſe; or without any active Power or Principle in Nature, of beginning and continuing Motion.

But if they muſt in the iſſue come to ſome firſt intelligent Cauſe, perhaps the ſooner the better: for why ſhould they give themſelves the trouble of creating an infinite number of imaginary Cauſes, to no purpoſe; and go a vaſt way about, to come at laſt to the ſame place, or poſſibly never to come to any reſult at all?

In the mean while, thoſe who ſhall endeavour to account for Gravity, otherwiſe than by reſolving it into the continued Action of the firſt Cauſe upon the whole material Syſtem, may perhaps keep far enough from Religion, and take ſufficient care, that *God is not in all their thoughts*; but will never, I fear, be able to advance any thing that is true, or conſiſtent in Philoſophy.

Upon the whole, the only true and right Method of reaſoning about natural Cauſes and Effects, is undoubtedly this, which the divine *Newton* has admirably exemplify'd; namely, to eſtabliſh in the firſt place, ſome very certain and moſt obvious Principles;

ſuch as may be evident in fact; and by a right application of theſe, to proceed to the more remote, and leſs obvious ſprings and movements of Nature.

By this means, if we cannot come to know all that we would, we ſhall at leaſt obtain a great deal of uſeful Knowledge, ſuch as will better pay the expence, than mere arbitrary Hypotheſes, and imaginary Schemes, which have nothing to ſupport them, but Ignorance and Preſumption.

PROPOSITION XVI.

THE abſolute central Forces, or Quantitys of Matter in attracting Bodys, are univerſally in the triplicate Ratio of the Diſtances of revolving Bodys from thoſe Centres directly, and the duplicate Ratio of the periodical Times inverſly: that is, thoſe Forces, or Quantitys of Matter, are ever as the Cubes of the Diſtances, divided by the Squares of the periodical Times.

For if r be put for Radius, or Diſtance in general, the centripetal Forces will be univerſally as $\frac{r}{p^2}$, by *Prop.* 8. And in this caſe, where the Diſtances are equal, r will be a ſtanding quantity; and conſequently, the Ratio of $\frac{r}{p^2}$ will be the ſame with $\frac{1}{p^2}$, or the reciprocal duplicate Ratio of the periodical

dical Times. But the Distances being equal, the centripetal Force will be as the absolute central Forces, or Quantitys of Matter in the attracting Bodys, by *Prop.* 14. and its *Corollary.* Therefore, those Quantitys of Matter at equal Distances will be as $\frac{1}{p^2}$ or $\frac{r}{p^2}$: but the Cubes of the Distances increase or decrease as the Squares of the periodical Times, by *Prop.* 11. and therefore at all Distances, the Ratio of $\frac{r^3}{p^2}$, will be the same with the Ratio of $\frac{1}{p^2}$ or $\frac{r}{p^2}$, at equal Distances; that is, as the Quantitys of Matter: And consequently at all Distances, putting r for the variable Distance, and p for the periodical Time in the revolving Bodys; the quantitys of Matter in the central attracting Bodys will be ever as $\frac{r^3}{p^2}$; or as the Cubes of the Distances directly, and the Squares of the periodical Times reciprocally, according to the Proposition.

PROPOSITION XVII.

THE Densitys of all central attracting Bodys, are ever in the compound reciprocal Ratio of the Cubes of the Parallaxes of the Bodys revolving about them, multiply'd into the Squares of their respective periodical Times.

To demonſtrate this, it muſt be obſerv'd in the firſt place, that the Denſitys of Bodys are ever as their Quantitys of Matter, divided by their Magnitudes: For if the Magnitudes are equal, the Denſitys will be directly as the Quantitys of Matter; and the Quantitys of Matter being equal, the Denſitys muſt be reciprocally as the Magnitudes: therefore they will be univerſally in the Ratio compounded of both; or as the Quantitys of Matter divided by the Magnitudes.

It muſt be obſerved farther, that the real Diameters of Bodys are as their apparent Diameters multiply'd into their Diſtances. For if the Diſtances are equal, 'tis evident the real Diameters will be as the apparent Diameters, or as the Angles ſubtended by thoſe Diameters themſelves: But if the apparent Diameters are equal, the abſolute or real Diameters will be as the Diſtances. Therefore univerſally, the real Diameters will be in the Ratio compounded of the apparent Diameters and the Diſtances. Conſequently, if d be put for Diſtance, and m for apparent Diameter, the real Diameters will be ever as $m\,d$: but 'tis well known, that the Magnitudes of Spheres are as the Cubes of their Diameters; and therefore, where the Diameters are as $m\,d$, the Magnitudes will be as $m^3\,d^3$. But the apparent Diameter of any given central Body at the Diſtance of its revol-

revolving Body or Satellite, is equal to twice the Parallax of that revolving Body; therefore the Magnitudes, which are in the triplicate Ratio of the apparent Diameters and Distances, will likewise be in the triplicate Ratio of those same Distances, and these Parallaxes, which are the apparent Semidiameters: that is, putting l for the general Expression of Parallax, and d as before for Distance; the Magnitudes will be as $d^3\ l^3$. Now by the last Proposition, the Quantitys of Matter are ever as the Cubes of the Distances divided by the Squares of the periodical Times; or putting d for Distance, and p for periodical Time, the Quantitys of Matter will be as $\frac{d^3}{p^2}$: And since the Densitys are universally as the Quantitys of Matter divided by the Magnitudes, therefore $\frac{d^3}{p^2}$, the general Expression for the Quantity of Matter, being divided by $d^3\ l^3$ the general Ratio of the Magnitudes, the Quote will be $\frac{1}{l^3 p^2}$; which is the general Expression for the Ratio of the Densitys: That is, the Density will be ever in the Ratio compounded of the Cubes of the Parallaxes, and the Squares of the periodical Times, reciprocally.

SCHOLIUM.

FROM what has been demonſtrated in theſe two laſt Propoſitions, the Diameters and Magnitudes of the Sun and Planets, together with the proportional Quantitys of Matter, and Denſitys of all ſuch Bodys as have other Bodys revolving about them, may be eaſily determin'd.

FOR ſince the apparent Diameters of the Planets, at their proper and reſpective Diſtances from the Sun, are given by Aſtronomical Obſervation; namely, that of *Saturn* 18″, of *Jupiter* 40″, of *Mars* 8″, of the *Earth* 22″, of *Venus* 28″, and of *Mercury* 20″. And ſince their proportional Diſtances from the Sun are likewiſe given as before ſhewn at *Prop.* 11. therefore, by what has been demonſtrated in this Propoſition, theſe apparent Diameters multiply'd by the reſpective proportional Diſtances, will give the Ratio of the real Diameters: And becauſe the Diameter of the Earth is given in a known Meaſure, namely 7968 *Engliſh* Miles, the Diameters of the Sun and Planets will be likewiſe given in the ſame Miles. According to which Computation, the Sun's Parallax being ſuppoſed as here 11″, and the Diameter of the Earth 7968 *Engliſh* Statute Miles; the Diameter of the Sun will be 700000, of *Saturn* 62150, of *Jupiter* 75300, of *Mars* 4414, of *Venus* 7250, of *Mercury* 2800, and of the *Moon* 2180 ſuch Miles.

Miles. And Spheres being as the Cubes of their Diameters, if the Magnitude of the Earth be put equal to Unity, that of the Sun will be as 681500, of *Saturn* 474, of *Jupiter* 844, of *Mars* $\frac{1}{6}$, of *Venus* $\frac{3}{4}$, of *Mercury* $\frac{1}{23}$, of the *Moon* $\frac{4}{159}$.

And by purſuing the Computation for the Quantitys of Matter and Denſitys of ſuch Bodys in the Solar Syſtem, as have other Bodys revolving about them; it will appear, that if the Quantity of Matter in the Earth be taken as 1, that of the Sun will be as 170000, in *Saturn* as 39, in *Jupiter* as 154.

And for the Denſitys; ſuppoſing the Denſity of the Sun as 100, that of the Earth will be as 400, of *Jupiter* as 73, and of *Saturn* as 33.

It may be obſerved here, that the Quantity of Matter in the Moon, is to the Quantity of Matter in the Earth, as 1 to 40; and the Denſity of the Moon, to that of the Earth, as 5 to 4 nearly: which cannot, indeed, be deduced from the foregoing Propoſitions, but will be demonſtrated afterward upon another Principle, and in its proper place.

Now by comparing theſe Proportions, it will appear, that the Denſitys of the primary Planets are nearly in the reciprocal Ratio of their Diſtances from the Sun. And ſince this Proportion appears ſo remarkable, and with ſo little Variation in the Earth,

Jupiter and *Saturn*, which having other Bodys revolving about them, admit of demonſtrative Calculation, as above; 'tis reaſonable enough to ſuppoſe from the Analogy, Uniformity and Simplicity of Nature, that the ſame Proportion obtains likewiſe with reſpect to *Mars*, *Venus* and *Mercury*: and tho for want of any diſcoverable Satellites or ſecondary Planets revolving about theſe latter, the thing cannot be determined with certainty and to a demonſtration; yet, where Nature is found to keep to ſome certain general Law, ſo far as our Enquirys and Obſervations can reach, 'tis very reaſonable to conclude, that the ſame Law obtains alſo ſtill farther, and where the like Obſervations cannot be made.

Now this being admitted or ſuppoſed, the Quantitys of Matter, and Denſitys of the Sun and Planets, taken all together, will be as here ſet down.

	Quantitys of Matter.	*Denſitys.*
The Sun	170000	100
Saturn	474	33
Jupiter	844	73
Mars	$\frac{1}{3}$	260
The Earth	1	400
The Moon	$\frac{4}{125}$	500
Venus	1	550
Mercury	$\frac{1}{9}$	1000

PROPOSITION XVIII.

IF a Body, as P, *revolves about another Body* S ; *that other will likewiſe revolve about the former ; that is, they will both revolve in the ſame Time about their common Centre of Gravity : And the Figures deſcribed about the common Centre of Gravity, and about each other mutually, will be reſpectively ſimilar.*

SUPPOSE two Bodys, S and P, *Fig.* 4. to attract or tend to each other mutually ; and let C be their common Centre of Gravity ; then will P C repreſent or expound the accelerating Velocity of P towards S ; and S C the accelerating Velocity of S towards P. Now if P deſcribes the Arch P *p*, in a given Time, S muſt deſcribe the Arch S *ſ* in the ſame Time, about the common Centre C ; ſo that the Arches deſcribed, P *p* and S *ſ*, may be as the accelerating Velocitys, P C and S C ; for by that means alone, can the Bodys be retained at a given Diſtance ; which muſt otherwiſe approach ſtill nearer and nearer to each other, by their mutual Attraction, till they come to a Contact. But the Figures C P *p*, and C S *ſ*, deſcribed by the Bodys P and S, about the common Centre C, are plainly ſimilar : and becauſe C P and C S are in a given Proportion, namely, as S to P ; therefore by compounding, C P + C S will be in the ſame given

given Proportion: and the Figure deſcribed by P about S, conſidered as immovable, will be equal and ſimilar to the Figure deſcribed by S about the Centre P; and both ſimilar to the former, namely, in the conſtant Ratio of the Radii C P, C S, and S P, or *ſp*.

PROPOSITION XIX.

IF two Bodys, S *and* P, *attract or tend to each other mutually, with given Forces, and at the ſame time revolve about the common Centre of Gravity* C; *I ſay, that with the ſame Figures thus deſcribed about the common Centre of Gravity, a ſimilar and equal Figure may be deſcribed with the ſame Forces, by either of thoſe Bodys about the other conſidered as immovable.*

SUPPOSE in the firſt place, *Fig.* 5. the Orbits P R and S Q, to be deſcribed about the common Centre C; and let P*p* and S*ſ* be the Arches deſcribed in the ſame Time. Let the Line S C*p* be ſuppoſed to move parallel to it ſelf, till it coincides with the Line S*q*, and the Point *ſ* comes to S; and let this be ſuppoſed to be done, in all the correſpondent Points of the Curves S Q and P R. 'Tis plain, that upon the appulſe of the Point *ſ* to S, the other extreme of the Line *ſp* will be at *q*, the Point in the Curve P*q*, to which the Body P would have come in the ſame Time, by its Revolution about S, conſidered as immovable; and with the

ſame

ſame Force, by which the Bodys were before ſuppoſed to tend mutually to each other: for the parallel tranſlation of the Line Sp, makes no difference or alteration at all of the Forces tending from P to S, and from S to P. But P q is the Arch deſcribed in the ſame Time, by the Body P about S as a Centre, and the Line S q is of the ſame Length, and has the ſame Inclination to the Line S P with Sp. Theſe Figures, therefore, being perfectly and exactly correſpondent, they muſt be equal and ſimilar. And what has been here proved of P moving about S as a Centre, muſt for the ſame Reaſons hold good of S moving about P as its Centre.

COROLLARY I.

From hence it follows, that if any two Bodys attract, or tend to each other mutually, and revolve about their common Centre of Gravity; they will by Radii drawn from that common Centre, and from each other reſpectively, deſcribe Areas proportional to the Times.

COROLLARY II.

From hence it likewiſe follows, that if two Bodys attract each other, and revolve about their common Centre of Gravity; their Motions will be the ſame as if they did not attract each other mutually, but were both attracted by a third Body placed in the Centre of Gravity, with the ſame Force by which they attract each other. For in *Fig.* 4. 'tis evident,

evident, that the Forces with which the Body P tends to S, are directed to ſome Point in the Line PS, produced towards S; and likewiſe the Forces of the Body S are directed to ſome Point in the ſame Line, produced towards P: But C is the only Point in the Line S P, which remains immovable in every poſition of the Bodys S and P; and therefore C is that Point to which the Bodys S and P tend, with the ſame Forces by which they attract one another.

PROPOSITION XX.

IF two Bodys attracting each other mutually, revolve about their common Centre of Gravity, the Diſtances remaining the ſame; the periodical Time about the Centre of Gravity, is to the periodical Time of one of thoſe Bodys revolving about the other, by the ſole Attraction of that other, in the ſubduplicate Ratio of the fix'd or central Body to the Sum of the Bodys.

FROM the well-known Property of the Centre of Gravity, the Diſtances of any two revolving Bodys from that Centre, are reciprocally as the Bodys themſelves: but the Bodys themſelves, or the Quantitys of Matter contain'd in them, the Diſtances being equal, are as the centripetal Forces; therefore, the centripetal Forces, in this caſe of equal Diſtances, are as the Bodys reciprocally. But by *Prop.* 8. the centripetal Forces

ces are ever in a Ratio compounded of the Distances directly, and the Squares of the periodical Times reciprocally; and therefore, where the Distances are equal, those Forces are as the Squares of the periodical Times reciprocally; and consequently the periodical Times as the Square Roots of those Forces reciprocally: that is, reciprocally as the Square Roots of the attracting Bodys. But in the Revolution of the Bodys about the Centre of Gravity, both Bodys are supposed to attract; but where one of the Bodys revolves about the other as a Centre, only the central quiescent Body is considered as attracting. Therefore the periodical Time in the former Case, will be to the periodical Time in the latter, as the Square Root of the centripetal Force in the latter, to the Square Root of the centripetal Force in the former; that is, in the subduplicate Ratio of the central quiescent Body, to the Sum of the Bodys: Which was to be demonstrated.

PROPOSITION XXI.

THE same things supposed as in the last Proposition; I say, that the periodical Times being equal, the Distance of the Bodys revolving about their common Centre of Gravity, is to the Distance of the same Bodys, where one of them revolves about the other considered as immovable, in the subtriplicate Ratio of the Sum of the Bodys to the fix'd or central Body.

PUTTING r for Radius or Diſtance, and p for periodical Time, the centripetal Forces are ever as $\frac{r^3}{p^2}$, by *Prop.* 16. Therefore p being every where the ſame, or the periodical Times equal, the centripetal Forces will be as r^3: that is, as the Cubes of the Diſtances; and conſequently the Diſtances as the Cube Roots of the centripetal Forces. But in this Caſe, the centripetal Forces are as the attracting Bodys; and therefore thoſe Forces which are as the Cube Roots of the Diſtances, will be as the Cube Roots of the attracting Bodys: that is, the Diſtance in the firſt Caſe, will be to the Diſtance in the ſecond, as the Cube Root of the Sum of the Bodys, to the Cube Root of the fix'd or central Body.

SCHOLIUM.

IT has been ſhewn at *Prop.* 72. that a Body at the Diſtance of 60 Semidiameters, would revolve about the Earth, by the ſole Attraction of the Earth, in the periodical Time of 39343 Minutes: and this being the periodical Time of the Moon, the Moon's mean Diſtance has been accordingly there ſuppoſed to be 60 of the Earth's Semidiameters. But becauſe the Earth and Moon do in fact and reality revolve mutually about their common Centre of Gravity; and

the Quantity of Matter in the Earth, is to the Quantity of Matter in the Moon, as about 40 to 1; therefore their mean Distance will be something more than 60 of the Earth's Semidiameters, in the subtriplicate Ratio of 41 to 40; and consequently the mean Distance by the whole conjunct Forces of the Earth and Moon, will be $60\frac{1}{2}$ Semidiameters nearly. But then because the Sun by his Attraction upon the Earth and Moon, does in some measure disturb their Motions, and upon the whole lessen their mutual tendency to each other, as shall be shewn afterward; therefore the true mean Distance in fact, and as determin'd by Observation, is $60\frac{1}{4}$ of the Earth's Semidiameters: At which distance, the apparent Semidiameter of the Moon, by the exactest Observations, is $31'\ 16''$; and her Horizontal Parallax, $57'\ 4''$.

PROPOSITION XXII.

IF a Body revolving about a given Centre, has its Motion disturb'd by the Attraction of some other Body drawing it to a different Centre; 'tis requir'd to find the general Laws and Proportions of the perturbating Forces.

IN *Fig.* 6. let S represent the Sun, T a primary Planet, as the Earth revolving about the Sun in the Orbit *e e*; and L a secondary Planet, as the Moon, revolving about T, in the Orbit A B C D. Let S T represent the Attrac-

Attraction of T towards S, and likewise the Attraction of L towards S, at its mean Distance. Take S*r* to S T, in the duplicate Ratio of S T to S L; and S*n* to S T, in the same duplicate Ratio of S T to S *l*: then will S*r* and S*n* expound the Attractions of the Body L towards S, in the Points L and *l* respectively. Complete the Parallelograms M S G*r*, and *t* S *g n*; then the Force, as *r* S, which expounds the Attraction towards S at the Point L, will by *Prop.* 3. be resolved into the two Forces *r* M and M S; and the Force *n* S, which expounds the Attraction towards S at the Point *l*, will be resolved into the Forces *n t* and *t* S.

Now the Forces *r* M and *n t* being directed as L T or *l* T towards T, will not at all disturb the Motion of the Body L about its Centre T; but notwithstanding this Force, the Areas described about T, as a Centre, would be still proportional to the Times, after the same manner, as if the Body at L or *l*, was not attracted at all to the Point S. But the Forces which are as M T and T *t*, being the Excess and Defect of the Attractions at L and *l*, with respect to the mean Attraction at T towards S, and being directed not to T as before, but to a different Centre S, will disturb the Motion of the Body L about T: And this Perturbation, in its Effects, will be proportional to the perturbating Forces M T or T *t*; which are the sole and adequate Causes of it.

Now

Now 'tis manifeſt, that when S L and S *l* is equal to S *t*, (that is, when the Body L is in or near the Points A or C;) the Points M and *t* will coincide with T; and the Forces, as M T and T *t*, will vaniſh, or become equal to nothing. But when L and *l* coincide with B and D; that is, in the Conjunction or Oppoſition of the Satellite with the Sun, the Force, as M T or T *t*, and conſequently the Perturbation of Motion towards T, will be greateſt. And here it muſt be obſerv'd in the firſt place, that the Forces, as M T or T *t*, being in their mean Quantity equal to L T or *l* T, will be always given, as being expounded by the Diſtance of L from T, which is ſuppoſed to be known: and ſecondly, where L T bears but a ſmall Proportion to T S; as is the Caſe with reſpect to the Diſtance of the Moon from the Earth, and the Earth from the Sun; I ſay, in this caſe the Force, as *r* M or L M, at the Quadratures, will be to the Force M T or T *t*, at the Conjunction or Oppoſition, nearly and without any ſenſible error, as 1 to 3: and therefore, if the Proportion L T to T S be given, the Proportion of the ſame L T to any other Quantity, whoſe Ratio to T S is given, may be eaſily found.

COROLLARY I.

From this general Conſtruction it follows, that by the Attraction and Perturbation of the Sun at S, the Motion of the

Body L about the Centre T, will be accelerated from the Quadratures to the next Conjunction or Oppoſition; and as much retarded from the Syzygys to the Quadratures.

FOR while the Body moves from A to B, in the ſame *Fig. 6.* the perturbating Force M T being directed from M or T towards S, by conſpiring with the proper Motion of the Body L in its Orbit, muſt accelerate it towards B. But from B to C, the ſame Force M T directed towards S, being contrary to the Motion of the Body in its proper Orbit, muſt retard it juſt as much as it had been accelerated before from A to B: but in the Motion from C to D, the central Body T will be more attracted towards S, than the revolving Body L, by the Exceſs T *t*; which is evidently the ſame thing, with reſpect to the ſenſible Effect at *l*, as if the Body T, retaining its former Poſition, or not being attracted towards S by any Exceſs at all, the Body at *l* ſhould be attracted the contrary way, from *l* to *q*, or from T to M; which conſpiring with its proper Motion towards D, muſt accelerate it again; and for the ſame reaſon and neceſſity, in its progreſſive Motion from D to A, it will be as much retarded: that is, it will be accelerated from the Quadratures to the Syzygia, and retarded from the Syzygia to the Quadratures, by the Exceſs or Defect of the perturbating Force, which

which is expounded or repreſented by M T or T *t*.

COROLLARY II.

FROM hence 'tis plain, that in the ſame Caſe as before, the greateſt Perturbations of Motion are in the Syzygys and Quadratures. For in the Quadratures A and C, the Forces M T and T *t* vaniſh; and the Tendency of the Body L to the Centre T, is augmented by the whole Force *r* M. But in the Syzygia B and D, the Gravity towards T is ſtill increaſed by the Force which is as L T, but diminiſhed by the Force M T = 3 L T: but 3 L T — L T = 2 L T; and conſequently the diminution of Gravity in the Syzygia is twice as great as its augmentation in the Quadratures.

COROLLARY III.

HENCE alſo as theſe perturbating Forces, *r* M and M T, either accelerate or retard the Motion of the Moon in her elliptick Orbit about the Earth, the Eccentricity of her Orbit will be perpetually changing, and increaſed or diminiſhed by turns, ſo as ſometimes to amount to 66782 of ſuch Parts, as her mean Diſtance contains 1000000; and at other times not to exceed 43319 ſuch Parts. And as this is certain in fact from Aſtronomical Obſervation, ſo it exactly agrees by Calculation with theſe perturbating Forces,

ariſing from the Sun's Attraction, as the adequate Effect of ſuch a Cauſe.

COROLLARY IV.

HENCE if the Diſtance L T be call'd r, T S, R, the periodical Time of L about T, p, and the periodical Time of L and T about S, P; the perturbating Force r M will be to the Force by which the Body L is retain'd in its Orbit about T, as $\frac{p^2}{P^2}$: for the Ratio of the perturbating Force r M or L T, to the Force by which the Body L is retain'd in its Orbit about L, is compounded of the Ratio of L T to T S, and of T S to the Force by which L revolves about T: but T S expounds the Force by which T revolves about S, by the Conſtruction; and this Force is as $\frac{R}{P^2}$ to $\frac{r}{p^2}$, *Prop.* 8. that is, as the Diſtances directly, and the Squares of the periodical Times reciprocally. Therefore the perturbating Force, as L T or r, is to the Force by which the Body L revolves about S, in the Ratio compounded of $\frac{r}{R}$ and $\frac{Rp^2}{rP^2}$; that is, $\frac{rRp^2}{RrP^2}$, or as $\frac{p^2}{P^2}$.

COROL-

COROLLARY V.

THE Distance L T, and the periodical Time of L about T, remaining the same, the perturbating Force r M or L T, will be as the Cube of T S reciprocally: for this Force being as $\frac{p^2}{P^2}$ by the last Corollary; if p^2 be a standing Quantity, the same Force will be as $\frac{1}{P^2}$: that is, as $\frac{1}{R^3}$, by *Prop.* 9. For since by that Proposition, the Squares of the periodical Times are ever as the Cubes of the Distances; therefore the Ratio $\frac{1}{P^2}$ will be equivalent to $\frac{1}{R^3}$: that is, the periodical Time of the perturbated Body, and its Distance from the Centre of its Motion remaining the same, the perturbating Force, as r M or L T, will be as the Cubes of the Distances of the perturbating Body or Bodys reciprocally. And universally, since these Forces are $\frac{p^2}{P^2}$, and since $p^2 : P^2 :: r^3 : R^3$; therefore, $\frac{p^2}{P^2} = \frac{r^3}{R^3}$. And consequently, if p and r be considered as standing Quantitys, the perturbating Forces will be as $\frac{1}{P^2}$, or $\frac{1}{R^3}$: but if P and R be considered as standing Quantitys, the perturbating Forces will be

as $\frac{p^2}{1}$, or as $\frac{r^3}{1}$: from whence the Ratio of the Distances or periodical Times being given, the Ratio of the perturbating Forces will be found.

COROLLARY VI.

HENCE likewise these perturbating Forces are ever as the Cubes of the apparent Diameters of the perturbating Bodys, multiply'd into their Densitys. For 'tis evident, that at equal Distances, the perturbating Forces must be as the Quantitys of Matter in the perturbating Bodys ; that is, as the Cubes of their Diameters multiply'd into their Densitys. But in this case, the apparent Diameters are as the real Diameters ; and therefore the perturbating Forces will be as the Cubes of the apparent Diameters multiply'd into the Densitys. And because the Cubes of the apparent Diameters are inversly as the Cubes of the Distances ; and the perturbating Forces increase or decrease in the same inverse triplicate Ratio of the Distances, by what has been already demonstrated ; therefore, at all Distances, these perturbating Forces, will be as the Cubes of the apparent Diameters of the perturbating Bodys multiply'd into their Densitys.

SCHO-

SCHOLIUM II.

UPON the same Principles, and by a like Method of reasoning, *mutatis mutandis*, the Phænomena of the Tides may be explain'd and accounted for. To which purpose, *Fig.* 6. let A B C D represent the Earth, supposed to be covered with Water; T the Centre, L a small portion or particle of Water upon the Surface, and S the Sun, or some distant Body, to which the Waters gravitate, or by which they are attracted in the inverse duplicate Ratio of the Distances. Then if T S expounds the Attraction of the Fluid at T towards S, S will expound the Attraction at L, and *n* S the Attraction at *l*; which will be resolved into two Forces, as M S and *r* M, and *t* S and *n t*. And consequently *r* M, M T and *t* T, *n t*, will represent the Excess and Difference of the Attractions at L and *l*, above and below the mean Attraction T S; which will be therefore proportional to the perturbating Forces. 'Tis manifest that the weight or tendency of the Fluid at L towards the Centre T, will be lessen'd by the Force as M T, and increased by the Force as L T: And therefore, when by the Convolution of the Earth about its Axis, the Point L comes to B; since M T or *t* T in this, will be equal to 3 L T; the Gravity at B and D will be lessened by a Force, as 3 L T — L T, or 2 L T, and increased at A and C by the Force as L T: which is the same thing in effect, as

if the Force as L T, did not act at all at the Quadratures A and C; but the Gravitys in the Syzygys B and D, were lessened by the whole Force M T, or $T t = 3 L T$. Now from this diminution of Gravity, 'tis evident that the Fluid must recede from A towards B, and from C towards D, and ascend at the Points B and D, to keep up its Æquilibrium: by which means, the Sphere A B C D will be reduc'd to an oblong Spheroid, whose greater Diameter D B continued, will pass thro the Centre of the Sun at S. And from hence, by the Revolution of the Earth about its Axis, the Waters will flow and reflow, to and from the Points B and D alternately; and there will be two Tides and two Ebbs in 24 Hours.

The same thing will happen by the Attraction of the Moon; only the Attraction of the Moon being much stronger than that of the Sun, the Effect will be proportional. But it must here be observed, that from these two Causes, there will not be form'd two distinct Tides: for the stronger Attraction must prevail in the sensible Effect, and produce one compound Tide; which will be as the Aggregate or Difference of the two Forces, as they happen to conspire with, or to oppose each other.

PRO-

PROPOSITION XXIII.

IF a Corpuſcle be placed within a Concave Sphere, whoſe Surface conſiſts of Parts attracting each other mutually, in the reciprocal duplicate Ratio of their Diſtances; the ſaid Corpuſcle thus placed any where within the Concavity, will not be attracted at all, but every where remain in a ſtate of Reſt or Æquilibrio.

LET *a b c d a* be the Surface of ſuch a Sphere, and *p* a Corpuſcle placed any where *ad libitum*, within its Concavity, *Fig.* 7. By *p* draw the Lines *a d*, *b c*, intercepting the ſmall Surfaces *a b*, *c d*: the Figures *a p b* and *c p d* being ſimilar, the Arches *a b*, *c d*, will be proportional to the Radii *a p*, *p d*, or *b p*, *p c*; and the ſpherical Surfaces *a b*, *c d*, will be in the duplicate Ratio of thoſe Radii reſpectively. Therefore the Attraction of the Corpuſcle *p* to the ſpherical Surfaces *a b* and *c d* will be equal. For with regard to the Quantity of Matter in the ſpherical Surface *c d*, the Corpuſcle *p* muſt be more attracted to the ſaid Surface *c d*, than to the Surface *a b*, in the duplicate Ratio of *c p* to *b p*; and with regard to the greater Diſtance *c p*, the ſaid Corpuſcle will be leſs attracted to the ſame Surface *c d*, than to the Surface *a b*; and that in the ſame duplicate Ratio of *c p* to *b p*, which muſt therefore conſtitute a Ratio of Equality; and conſequently thoſe equal Attrac-

tions

tions in contrary Directions, muſt mutually deſtroy each other. And by the like method of reaſoning, all the Attractions throout the whole Concavity of the Sphere, will be deſtroy'd by equal Attractions in contrary Directions; and the Corpuſcle *p*, any where poſited within the ſaid Concavity, will remain in a ſtate of Reſt or Æquilibrio: *Which was to be demonſtrated.*

COROLLARY I.

HENCE in a ſolid Sphere, whoſe conſtituent Parts attract each other mutually, in the reciprocal duplicate Ratio of their Diſtances, the Attractions of equal Corpuſcles within the Surface to the Centre of the Sphere, will be in the ſimple direct Ratio of their Diſtances from the Centre. For by the laſt Propoſition, a Corpuſcle at *a*, *Fig.* 8. is not at all attracted to the Surface A B C D; that Attraction being every where deſtroy'd by equal Attractions in contrary Directions: and therefore the Attraction of the Corpuſcle *a* to the Centre R, will be the ſame as if it lay upon the Surface of a Sphere of the ſame Denſity, whoſe Radius ſhould be equal to R *a*; that is, the Denſitys being equal, as is here ſuppoſed, the Attractions of the Corpuſcles A and *a* to the Centre R, will be as the Spheres A B C D and *a b c d* directly, and the Squares of the Diſtances R A and R *a*, reciprocally: namely, as R A Cube × R *a* Square to R *a* Cube × R A Square; or

as

as RA to R*a*. Therefore if a ſolid Sphere conſiſts of Parts, which attract each other as the Squares of the Diſtances reciprocally, Corpuſcles placed within the Surface of any ſuch Sphere, will be attracted to the Centre in the ſimple direct Ratio of their Diſtances from the ſame Centre: *Which was to be demonſtrated.*

COROLLARY II.

If a Cavity be conceived to be made quite thro the Earth, according to the Direction of its Diameter; from whatever Altitude a Body be ſuppoſed to be let fall in the ſaid Cavity towards the Centre, it will come to the Centre in the ſame given Time; and being arrived to the Centre, it will aſcend to the ſame Altitude on the other Side, and then return to the Point from which it was let fall; and ſo continue this Reciprocation of Aſcent and Deſcent, after the manner of a vibrating Pendulum. For ſince in all moving Bodys, the Times are ever as the Spaces to be deſcribed directly, and the Velocitys reciprocally; that is, as the Spaces divided by the Velocitys: 'tis manifeſt, that where the Velocitys increaſe or decreaſe in proportion to the Spaces to be deſcrib'd, all Spaces, by Bodys moving according to this Law, will be deſcrib'd or paſs'd thro in the ſame or equal Time. But in this caſe of the perpendicular deſcent of Bodys within the Surface towards the

Centre

Centre of the Earth, the Velocitys are the accelerating Gravitys towards the Centre, which are as the Diſtances from the Centre, by the Propoſition; which Diſtances from the Centre are the Spaces to be deſcrib'd, by the Suppoſition: And therefore both theſe muſt conſtitute a Ratio of Equality; and the Deſcent of Bodys thro all Altitudes from within the Earth's Surface towards the Centre will be perform'd in the ſame or equal Times. Now whatever Velocity a Body acquires, in falling from any given Altitude within the Surface to the Centre of the Earth, will oblige it to aſcend to the ſame Altitude on the other Side; where the Force acquired in its fall being deſtroy'd, it will return by the Attraction of the Centre, and aſcend again by the ſame Force to the ſame Altitude from which it was let fall. And thus abſtracting from all Reſiſtance, it muſt for ever continue its reciprocal Aſcent and Deſcent, after the manner of a vibrating Pendulum.

PROPOSITION XXIV.

THE Time in which a Body let fall from any given Altitude within the Surface, would come to the Centre of the Earth, and aſcend again to the ſame Altitude on the other Side; that is, the whole Time of ſuch an Oſcillation, as ſuppoſed in the foregoing Corollary, is equal to the ſemi-periodical Time of a Body revolving about the Earth, at the Diſtance of one Semidiameter,

and

and retain'd in its Orbit by the ſole Force of Gravity, ſuch as it obtains at the Earth's Surface.

Fig. 9. LET a Body revolve in the Circle A *p* E Q, at the Diſtance A *r*, equal to the Semidiameter of the Earth; and let it be kept revolving by a Force equal to that of Gravity, as it obtains at the Earth's Surface: Then the central Force, and the tranſverſe Diameter, remaining the ſame, the Body, by what has been already demonſtrated, will deſcribe the Semi-ellipſes A *a* E or A *q* E, in the ſame Time with the ſemicircular Arch A *p* E. Let now the conjugate Diameter be leſſened *in infinitum*, and the Eccentricity increaſed, till the Foci come to coincide with the Extremitys of the tranſverſe Diameter, or with the Points A and E; then will the Ellipſes A *a* E or A *q* E degenerate into, or coincide with the right Line A E; and the Body will deſcribe the Line A E: that is, it will fall from A to the Centre *r*, and aſcend to E, in the ſame Time that it would deſcribe the Semi-ellipſes A *a* E, A *q* E; or the ſemicircular Arch A *p* E.

PROPOSITION XXV.

THE Time in which a Pendulum of any given Length will perform its Vibration, is equal to the ſemi-periodical Time of a Body revolving by the Force of Gravity in an Orbit, whoſe Radius or Semidia-

meter is equal to the Length of the Pendulum.

FOR ſince in *Fig.* 9. from whatever Point between A and *r* a Body be let fall, it will come to the Point *r*, and aſcend again to the ſame Height on the other Side, in a given Time; namely, in the ſemi-periodical Time of its Revolution about the Centre *r*, by the ſole Force of its own Gravity; and ſince a pendulous Body moving in a Cycloid, vibrates all Arches in the ſame Time, and moves by the ſole Force of its own Gravity; 'tis evident that the Law of Motion muſt be the ſame in both Caſes.

SCHOLIUM.

THIS Propoſition muſt be underſtood only of pendulous Bodys moving in Cycloids: for where a Pendulum moves in a circular Arch, it will take up ſomewhat a longer Time in vibrating a greater than a ſmaller Arch. The Time of Vibration therefore here limited, with reſpect to a circular Arch, will hold good but in the ſmalleſt or very minute Arches, and where the very ſmall Portion of the Circle may be ſuppoſed to coincide with the Cycloid. Now this being ſuppoſed, the Length of the Pendulum from the Time of its Vibration given, or on the contrary, the Time of Vibration from the Length of the Pendulum, are eaſily determin'd. For putting *e* for the Ratio between

tween the Perimeter and the Diameter of a Circle $= \frac{355}{113}$; r for the Radius or Length of the Pendulum; c for the accelerating Force of Gravity in one Second $= 16,1$ Feet; and p for the periodical Time; it will be $\frac{2re^2}{c} = p^2$, by *Prop.* 8. Now putting t for the Time of a Vibration, which is the semi-periodical Time of an intire Revolution; it will be $t^2 = \frac{1}{4}p^2$; and consequently $\frac{re^2}{2c} = t^2$: and therefore $\frac{2ct^2}{e^2} = r$. From whence 'tis plain, that the Lengths of Pendulums are as the Squares of the Times of Vibration, and the Times as the Square Roots of the Lengths. And for ready Practice, since the Length of a Pendulum beating Seconds, with us is 39,2 Inches; therefore putting a Second for Unity, the Square of the Time of Vibration, multiply'd by 39,2, gives the Length of the Pendulum in Inches; and the Length divided by 39,2, gives the Square of the Time.

PROPOSITION XXVI.

THE Space thro which a heavy Body will descend perpendicularly, during the Time that a given Pendulum performs its Vibration, is to half the Length of the Pendulum, in the duplicate Ratio of the Circumference to the Diameter.

THE

THE Space thro which a Body will deſcend perpendicularly in a given Time, is equal to the Square of the Arch deſcribed in the ſame Time, divided by the Diameter. But in this caſe, the Time of a Vibration is the ſemi-periodical Time of an intire Revolution; or the Time in which the Body revolving by the ſame Force of Gravity, would deſcribe the Semi-circumference, by the *laſt Propoſition*. And therefore, retaining the ſame Symbols as before, r^2 e^2, the Square of the Semi-circumference, divided by $2r$ the Diameter, gives $\frac{1}{2} r e^2$: But $\frac{1}{2} r e^2$, the Space deſcribed in the perpendicular Deſcent, during the Time of one Vibration, is to $\frac{1}{2} r$, half the Length of the Pendulum, as e^2 to 1; that is, as the Square of the Circumference to the Square of the Diameter.

COROLLARY I.

HENCE the Time in which a Pendulum performs its Oſcillation, is to the Time of perpendicular Deſcent thro half the Length of the Pendulum, in the Ratio of the Periphery to the Diameter. For thoſe Spaces being deſcribed by an accelerated Motion, and being in the duplicate Ratio of the Circumference to the Diameter, by the *Propoſition*; the Times, which are as the Square Roots of the Spaces, muſt be in the ſimple Ratio of the Circumference to the Diameter.

COROL-

COROLLARY II.

HENCE 'tis likewiſe evident, that the Length of a Pendulum vibrating in a given Time, is ever proportional to the accelerating Gravity; *i. e.* to the Space deſcribed by the perpendicular Deſcent of a Body in the ſame Time: But the Length of the Pendulum being the ſame, the Gravitys are as the Squares of the Times of Oſcillation inverſly; and conſequently, where by the nearer approach to, or farther receſs from the Centre of Attraction, the Gravity is increaſed or diminiſhed, this augmentation or diminution of Gravity may be eaſily determined.

PROPOSITION XXVII.

IF a large Sphere or Globe, ſuch as the Earth, be made to revolve about its Axis while it is in a ſtate of Fluidity, it will by ſuch a Motion acquire the form of an oblate Spheroid; in which the Proportion of its Axis to its æquatorial Diameter, will be as the Length of a Pendulum vibrating Seconds at the Æquator, to the Length of a Pendulum vibrating in the ſame Time at the Poles.

IF a fluid homogeneous Sphere conſiſting of Parts of an equal and uniform Denſity, be turned about an Axis, 'tis plain that the Gravitation of the Parts towards the Centre will be hereby leſſen'd or diminiſh'd, in pro-

portion to the centrifugal Force generated by ſuch a circular Motion. And becauſe the centrifugal Force increaſes from the Poles to the Æquator, where it is greateſt of all; therefore the Fluid muſt recede from the Poles, and riſe towards the Æquator, in order to retain its Æquilibrium; that the Length of the Canals may compenſate for the Diminution of Gravity: by which means the Sphere will be reduced to an oblate Spheroid. Now let A *a* E P, *Fig.* 9. repreſent the Earth revolving about its Axis P *a*; A E the Æquator, and the Points P and *a* the Poles: Let this Spheroid be ſuppoſed to conſiſt of ſmall cylindrical Canals of equal Baſes, communicating at the Centre; and 'tis plain, the abſolute Weights of the Canals A *r*, P *r*, *&c.* muſt be reſpectively equal: for in that caſe only can the Centre be equally preſs'd, and the Fluid retain'd *in Æquilibrio.* But theſe Weights are as the Quantitys of Matter multiply'd into the accelerating Gravitys; that is, in this Caſe, as the Lengths of the Canals, multiply'd into the accelerating Gravitys. And conſequently the accelerating Gravitys are reciprocally as the Lengths of the Canals: And therefore the accelerating Gravity at A, is to the accelerating Gravity at P, as P *r* to A *r*. But the accelerating Gravitys have a conſtant given Ratio to the Lengths of a Pendulum vibrating in the ſame Time, by the laſt *Propoſition*; and therefore the Canals will be likewiſe reciprocally

as

as theſe Lengths : that is, the Length of a Pendulum vibrating Seconds at A, will be to the Length of a Pendulum vibrating Seconds at P, as P *r* to A *r* : *Which was to be demonſtrated.*

PROPOSITION XXVIII.

SUPPOSING the ſame as in the laſt Propoſition ; the Augmentations of Gravity, in going from the Æquator to the Poles, will be in the duplicate Ratio of the Lines of the Latitude.

LET A P E *p*, *Fig.* 10. repreſent the Earth, A E the æquatorial Diameter, P *p* the polar Diameter or Axis ; and let D repreſent a Body ſuſpended by the Thread B D, and placed any where between the Æquator A, and the Pole P ; and draw D S perpendicular to the Axis P *p*. 'Tis plain, if the Earth had no diurnal Rotation, the Body D would draw the Thread B D into the Poſition B C, where it would ſtretch the Thread with the whole Force of its Gravity, by endeavouring to deſcend directly to the Centre *r* : or if we ſuppoſe the centrifugal Force to act according to the ſame Direction *r* C, it would then directly oppoſe the Force of Gravity, and the Thread would remain in the ſame Poſition, only it would be ſtretch'd but with the Difference of theſe two Forces. But becauſe the Body D turns round the Centre S, it will endeavour to recede from

the ſaid Centre in the Direction CD; by which means, the Thread will be drawn into the Poſition BD. Let D*n* be drawn perpendicular to BC; then if DC repreſent the centrifugal Force acting in the Direction SD, it is equivalent, by *Prop.* 3. to two Forces; one of which is as C*n*, and acts according to the Direction C*n*, which is contrary to the Force of Gravity towards *r*; the other as *n*D, and acts in the Direction *n*D, which is no way contrary to the Force of Gravity. If therefore CD repreſent the whole centrifugal Force at C, C*n* will repreſent that part of it which is contrary to the Force of Gravity. Draw D*m* parallel to the Axis P*p*; then will the Triangles C S*r*, C D*m*, and C D*n* be ſimilar: And therefore it will be, A*r* or C*r* : CS : : C*m* : CD : : CD : C*n*; and, C*r* : *r* S : : C*m* : D*m*. Conſequently, if CD repreſents the whole centripetal Force at C, and C*n* that part of it which is contrary to the Force of Gravity, C*m* will expound the centripetal Force at the Æquator, and *m n* the Augmentation or Exceſs of Gravity at C, above the Gravity at A. But *m*C is to *m n* in the duplicate Ratio of *m*C to *m*D, or of C*r* to *r*S; that is, the centripetal Force, or decreaſe of Gravity at the Æquator, is to the increaſe of Gravity, or diminution of the centripetal Force at C, as the Square of the Radius to the Square of the Line of the Latitude: and conſequently the Augmentations of Gra-

vity from the Æquator to the Poles, are in the duplicate Ratio of the Lines of the Latitude.

PROPOSITION XXIX.

THE Earth by the Rotation about its Axis, is reduced to an oblate Spheroid, whose Axis, or polar Diameter, is to the Diameter of the Æquator nearly as 124 *to* 125.

THE Length of a Pendulum which vibrates Seconds at *Paris*, is 36 *Paris* Inches, and $8\frac{5}{9}$ Lines, or $440\frac{5}{9}$ Lines; and by comparing together of many repeated Observations, with proper Allowances for the greater Heat and Rarefaction under the Æquator, it has been found, that a Pendulum beating Seconds at the Æquator, must be 2 Lines shorter than a Pendulum vibrating in the same Time at *Paris*: and consequently, a Pendulum whose Length is $438\frac{5}{9}$ Lines, will vibrate Seconds at the Æquator. Now the Latitude of *Paris* is 48° 50′: and since the Augmentations of Gravity are as the Squares of the Lines of the Latitudes, by the last *Proposition*; and the Gravitys are as the Lengths of the Pendulums, by *Prop.* 27. therefore, as the Square of the Line of the Latitude of *Paris*, or the Square of the Line of 48° 50′, is to the Square of the Radius, so is the Augmentation at *Paris*, 2 Lines, to the Augmentation at the Poles; which will

be found to be 3,529 Lines; which being added to 438,555, the Length at the Æquator, gives 442,084, the Length of a Pendulum beating Seconds at the Poles: but the Diſtances from the Centre are reciprocally as theſe Lengths; and therefore the Semiaxis of the Earth will be to its Semidiameter at the Æquator, as 438,555 to 442,084; that is, nearly as 124 to 125: *Which was to be demonſtrated.*

PROPOSITION XXX.

TO find the perturbating Forces of the Sun and Moon, upon the Ocean and Atmoſphere.

ACCORDING to the beſt and moſt accurate Obſervations, the mean Semidiameter of the Earth is 21034840 *Engliſh* Feet: and ſince the Ratio of the Earth's Axis to its æquatorial Diameter, is as 124 to 125, by the laſt *Propoſition*; therefore, the Semiaxis will be 20950363, and the æquatorial Semidiameter 21119317 *Engliſh* Feet; and their Difference 168954 Feet: which is the Elevation of the Æquator above the Poles, ariſing from the Rotation of the Earth about its Axis. And ſince by *Prop.* 22. and its *Corollarys*, the perturbating Forces are inverſly as the Squares of the periodical Times; therefore the centrifugal Force of the Æquator will be to the perturbating Force of the Sun, which is as M*r* or TL, *Fig.* 6. as the

the Square of the Earth's periodical Time about the Sun, to the Square of the Earth's periodical Time about its Axis; that is, as the Square of $366\frac{1}{4}$ to 1; or as 134139 to 1.

But the Force rM, is $\frac{1}{3}$ of the whole conjunct Forces rM and MT, by which the Fluid is depreſs'd at the Points A and C, and elevated at B and D; and conſequently the whole perturbating Force of the Sun, by which the Fluid is elevated in the vertical Points, or in the Sun's Zenith and Nadir, and depreſs'd in the Horizon of theſe Points, will be $\frac{3}{134139}$ or $\frac{1}{44713}$ of the centrifugal Force at the Æquator: And ſince the centrifugal Force at the Æquator raiſes the æquatorial Parts above the Polar 168954 Feet, as before ſhewn; therefore the perturbating Force ariſing from the Attraction of the Sun, will raiſe the Fluid in the Sun's vertical Points above the Horizon of thoſe Points $3\frac{7}{9}$ Feet: For, 44713 : 168954 :: 1 : $3\frac{7}{9}$. And becauſe by Obſervations made on the different Height of the Tides, at the New or Full Moons and Quadratures, the Force of the Moon, in this Caſe, is to that of the Sun as 9 to 2; therefore where the Sun by its ſingle and ſole Attraction raiſes the Waters $3\frac{7}{9}$ Feet, the Moon will elevate the ſame Fluid 17 Feet: For, 2 : 9 :: $3\frac{7}{9}$: 17. And ſince the ſingle Force of the Sun produces an Elevation of $3\frac{7}{9}$ Feet, and that of the Moon an Elevation of 17 Feet, the Sum of their

Forces, by which the Tides are raiſed at the New and Full Moons, will be $20\frac{7}{9}$; and their Difference at the Quadratures $13\frac{3}{9}$ Feet.

BUT theſe perturbating Forces of the Sun and Moon are ſubject to ſeveral Variations, ſome of which muſt be here brought into the Account, as being very ſenſible and conſiderable in their Effects. And,

1. WHAT has been hitherto ſaid, muſt be underſtood of the Sun's and Moon's Forces at their mean Diſtances from the Earth; but at other Diſtances, by what has been already demonſtrated, theſe Forces and their proportional Effects will be reciprocally as the Cubes of thoſe Diſtances, or directly as the Cubes of the apparent Diameters. And ſince the Eccentricity of the Earth in its annual Orbit about the Sun, is $\frac{1}{30}$ of the middle Diſtance, nearly; if the middle Diſtance be taken as 60, the greateſt Diſtance will be as 61, and the leaſt as 59: And therefore, at the greateſt Diſtance, the Elevation from the Attraction of the Sun will be $3\frac{1}{4}$; and at the leaſt Diſtance, the Elevation will be four Feet, *ferè*.

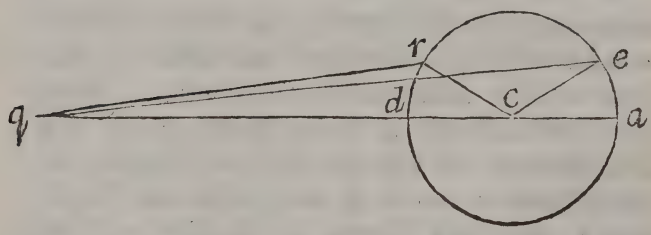
THE greateſt Eccentricity of the Moon in her Orbit is 6678 of ſuch Parts, as the mean Diſtance contains 100000; and conſequently, the Moon's greateſt Diſtance from the Earth will be 106678, and the neareſt 93322 ſuch Parts. And ſince the perturbating

ting Forces and their Effects are inverſly as the Cubes of theſe Diſtances, it will follow, that if the Attraction of the Moon at the Diſtance 100000, raiſes the Tides 17 Feet at the Diſtance 106678, the Elevation will be 14; and at the Diſtance 93322, the Waters will riſe to 21 Feet, nearly. But then,

2. WHAT has been here obſerved, ſuppoſes the Sun and Moon, or the Body by whoſe Attraction the Tides are raiſed, to be in the vertical Points, or in the Zenith or Nadir, where ſuch Elevations are produced. But in caſe the perturbating Body be at any Diſtance from the vertical Points, or leſs than 90 or $\frac{9r}{7}$, above or below the Horizon, theſe perturbating Forces and their Effects, will be leſſen'd in the duplicate Ratio of the Sines of the Altitudes to the Radius. Now the Latitude of a Place being given, its Complement to 90 *Gr.* is the Altitude of the Æquator where it interſects the Meridian; then any North Declination of the Sun or Moon added to, or South Declination ſubtracted from this Altitude of the Æquator, the Sum or Difference will be the Meridian Altitude of the Sun or Moon reſpectively: which being obtain'd; as the Square of the Radius is to the Square of the Meridian Altitude, ſo is the vertical Elevation $3\frac{7}{9}$ for the Sun, or 17 Feet for the Moon,

Moon, to the Elevation or Height of the Waters at the Place given.

3. THERE is another Difference of theſe perturbating Forces and their Effects, ariſing from the various Poſitions of the Sun and Moon with reſpect to each other, between the Conjunctions, or Oppoſitions, and the Quadratures. At the Conjunctions and Oppoſitions they act, as has been obſerv'd, with the Sum; but at the Quadratures, with the Difference of their Forces. But between theſe, thoſe Forces are variouſly combin'd; and in this caſe the compound Force, whether additional or differential, may be thus determined:



IN the Figure annex'd, let *q c* repreſent the perturbating Force of the Moon, or the Elevation of the Tides from the ſole Attraction of the Moon, and let *c a* expound the like Force of the Sun. Upon the centre *c*, with the Radius *c a*, deſcribe the Circle *a e d a*; then will *q a* repreſent the Sum of the Forces of the Sun and Moon, and *q d* the Difference of their Forces: make the Angles

a c e

a c e or *d c r*, equal to twice the Moon's Diſtance from the next Conjunction or Oppoſition; then will the Lines *q e* or *q r*, repreſent the compound Force or Elevation of the Waters at the Points *e* and *r* reſpectively. But in the Triangles *q e c* or *q r c*, the Sides *q c* and *e c*, or *q c* and *r c*, being given, with the Angles included, either of the other Angles, and conſequently the Sides *q e* or *q r*, will be eaſily found from the known Rules of *Plain Trigonometry*.

COROLLARY.

FROM hence it will be manifeſt, that theſe perturbating Forces bear ſo ſmall a Proportion to the Force of Gravity, that they cannot at all alter the Weight of Bodys with us, or be diſcover'd by the Riſe and Fall of the Mercury in the Barometer, nor by any other hydroſtatical Experiments whatever. For by what has been demonſtrated in the *Propoſition*, the perturbating Force of the Sun is to the centrifugal Force at the Æquator, as 1 to 44713; and the centrifugal Force at the Æquator is to the Force of Gravity with us, (by which Bodys deſcend 16,1 Feet in one Second) as the Square of the periodical Time at the Earth's Surface, to the Square of the periodical Time of the Earth about its Axis; that is, as the Square of $84\frac{3}{5}$ to the Square of $1436\frac{1}{15}$ Minutes, or as 1 to 287,69; and conſequently the perturbating Force of the Sun is to the Force

Force of Gravity in a Ratio compounded of 1 to 44713, and of 1 to 287,69; which is the Ratio of 1 to 12863470. It will farther appear by a Computation from the foregoing Principles, that the conjunct Forces of the Sun and Moon in their greatest Quantity, is to this mean perturbating Force of the Sun, as 33 to 5; and consequently this greatest compound Force, will be to the Force of Gravity with us, as 1 to 1949000; which cannot raise or sink the Mercury in the Barometer above $\frac{1}{57000}$ of an Inch. And therefore, if those who have made a serious Question of it, Why these perturbating Forces are not discover'd by the different Heights of the Mercury, at the New or Full Moons and Quadratures; and who have gone about to assign very remote and obscure Reasons for it, had but first reduc'd this Matter to a *Calculus*, they might have sav'd all their other Pains; since they would have found that the Cause they were considering, could not possibly have any such sensible Effect as they expected from it.

COROLLARY II.

From these Laws and Proportions of the perturbating Forces, it must likewise follow, that all the physical sensible Effects that can be produc'd from such a Cause, must be owing to the Sun and Moon; and that all the other Planets and Fix'd Stars are wholly to

to be rejected, and left out of the Account in an Inquiry of this Nature.

PROPOSITION XXXI.

ALL the physical sensible Effects that can proceed from such a Cause of Attraction and Perturbation of Motion in our Ocean and Atmosphere, must be owing to the Sun and Moon; and all the other Planets and Fix'd Stars are wholly to be rejected, and left out of the Account in the present Case.

FROM what has been already demonstrated, 'tis evident, that the Sun and Moon must have very sensible and considerable Effects upon our Ocean and Atmosphere; and by a Computation from the same Principles, it will appear, that the other Planets and Fix'd Stars can have no such Effects at all, that can come into any physical Account. For since by what has been shewn at *Prop.* 22. these perturbating Forces are ever as the Densitys of the perturbating Bodys, multiply'd into the Cubes of their apparent Diameters; therefore, where the Densitys and apparent Diameters are given, the Ratio of the perturbating Forces will be likewise given. Now the apparent Diameter of the Sun at a mean Distance is $32' 15''$, or $1935''$; and the Sun's Density 100; *Saturn*'s apparent Diameter, when nearest to us, is $22''$, and *Jupiter*'s $52''$; *Saturn*'s Density 32, and *Jupiter*'s 73. And therefore the Perturbation

tion of the Sun will be to that of *Saturn*, as the Cube of $\overline{1935} \times 100$, to the Cube of $\overline{22} \times 32$, or as 2175834 to 1: and consequently, where the Sun at a mean Distance raises the Tides $3\frac{7}{9}$ Feet, *Saturn* with his greatest possible Force will raise the Waters only $\frac{1}{4859}$ of an Inch. And by the same Method of reasoning, the perturbating Force of the Sun will be to that of *Jupiter*, as 70585 to 1; and *Jupiter*'s Attraction, when greatest, will not raise the Waters of the Ocean more than $\frac{1}{1557}$ of an Inch. But the Planet which seems to bid fairest for any real physical Effect upon our Ocean and Atmosphere, is *Venus*; whose Density, for want of a Satellite, cannot be exactly determin'd. But I shall suppose, that the same Ratio of the Densitys obtain'd here, as with respect to the Sun, the Earth, *Saturn* and *Jupiter*; that is, that the Density is reciprocally as the Distances; then will the Density of *Venus* be 550, her apparent Diameter, when nearest the Earth, is 80″; and then the Force of the Sun will be to that of *Venus*, as 2573 to 1; and *Venus* will only raise the Tide $\frac{1}{36}$ of an Inch: and the perturbating Force of *Mars* and *Mercury* will still be less. Farther, I shall suppose the Fix'd Stars to be of the same Density with the Sun, since they are manifestly Bodys of the same Nature and Kind: then will their perturbating Forces be as the Cubes of their apparent Diameters. Now a Fix'd Star has no sensible Diameter,

even

even when view'd thro a Teleſcope, which magnifys the Diameter 200 times; and conſequently the apparent Diameter of a Fix'd Star muſt be leſs than $\frac{1}{200}$ of a Minute, and will be to the apparent Diameter of the Sun, in a Proportion leſs than that of 1 to 6400: the perturbating Force of the Sun therefore will be to that of a Fix'd Star, in a Ratio greater than 26000000000 to 1. From whence it muſt follow, that if twenty ſix Millions of theſe Fix'd Stars were to be amaſs'd in one, or to act in the ſame Direction, their attractive Forces would not be ſufficient to raiſe the Waters of our Ocean the ten thouſandth Part of an Hair's breadth. Now 'tis plain that theſe attractive perturbating Forces of the Planets and Fix'd Stars, are phyſically evaneſcent, and of no moment at all; and conſequently all phyſical ſenſible Effects of this kind muſt be attributed to the Sun and Moon.

PROPOSITION XXXII.

WHAT has been hitherto demonſtrated, concerning the perturbating Forces of the Sun and Moon upon the Ocean, in producing the alternate Flux and Reflux of the Waters, muſt be conſequently underſtood alſo of the Atmoſphere, in which the ſame Perturbations of Motion muſt likewiſe happen.

THIS is evident from the Nature of the Atmoſphere, or Body of Air, which every

way ſurrounds the Earth, to the Height of about fifty Geographical Miles; and which being a Fluid, muſt neceſſarily be ſubject to the common Laws of all other Fluids. And conſequently, wherever its Gravity is leſſened, the Fluid muſt flow in from other Parts, and raiſe the Columns or Heights of the Fluid proportional to the Diminution of Gravity, in order to keep up the Æquilibrium.

PROPOSITION XXXIII.

THESE Perturbations of the Ocean and Atmoſphere muſt neceſſarily be impreſs'd upon the Blood and animal Fluids, and produce very ſenſible and conſiderable Effects in animal Bodys.

To underſtand and explain which, it muſt be obſerved in the firſt Place, that in theſe alternate Fluxes and Refluxes of the aqueous and æthereal Fluids, as often as the Motion comes to be chang'd, and the Fluids to be impreſs'd in a contrary Direction; this muſt throw the Fluids into a violent Commotion, or inteſtine mutual Colliſion and Struggle of the Parts among themſelves. Thus in *Fig. 6.* when the Moon or perturbating Body is ſuppoſed at S, the Fluid will recede from the Points A and C towards B and D, where the Elevation will be greateſt; becauſe the Diminution of Gravity will be there greateſt. But when by the Rotation of the

Earth

Earth about its Axis, the Points D and B come to A and C reſpectively: the Fluid, which before receded from A and C towards B and D, muſt now change its Direction, and flow on the contrary from B and D towards A and C. And hence by the inteſtine Commotion, Struggle, and mutual Colliſion of the Parts of the Fluid, the Sea muſt rage, foam, and fluctuate; ſomething like what happens in a Veſſel fill'd with any Liquor, which having a circular Motion given it one way, when that Direction comes to be changed for a contrary one, the Fluid will by the inteſtine Commotion and mutual Colliſion of its Parts, riſe, fluctuate, and fly over the Sides of the Veſſel. Now by this Agitation and inteſtine Commotion of the Waters, the ſmaller and lighter Parts of the Fluid, ſuch as ſeparated from the reſt, will be thrown upon the Surface in a ſort of Foam or Froth; where by a farther Agitation from the Heat of the Sun, they will eaſily riſe in Vapour, and fill the Atmoſphere with aqueous Particles. The Quantity of Vapours therefore riſing in a given Time, will be *cæteris paribus*, proportional to theſe Perturbations of the Waters by the Sun and Moon. And indeed, this thick, foggy, and humid Diſpoſition of the Air, ſeldom fails of diſcovering it ſelf to Obſervation and Senſe, even in the drieſt Seaſons.

But this inteſtine Motion and mutual Colliſion of the Parts of the Fluid, from the Cauſe juſt now aſſign'd, muſt be ſtill greater in the Atmoſphere, on the account of its Elaſticity. For the Parts here having no mutual Attraction and Coheſion, but on the contrary a centrifugal Force, any Motion impreſs'd muſt have the greater Effects; and the Atmoſphere, by the mutual Colliſion and Struggle of its Parts, will be thrown into the more violent Commotion, and become the more turgid and fluctuating; which muſt conſiderably heat and rarefy the fluid elaſtick Æther.

It muſt be here obſerv'd farther, what is very evident in Fact, and confirm'd by numberleſs Experiments, that the Blood, and all other Fluids, have their Pores and Interſtices fill'd with Air: and there being a continual Communication between the Atmoſphere or external Air, and the Air included or contain'd in ſuch Fluids, any Conſtitution, Impreſſion or Determination given to the one, muſt likewiſe be communicated to, and equally affect the other. From whence it muſt follow, that the Atmoſphere or external Air, being put into any violent inteſtine Commotion, or mutual Colliſion and Agitation of its Parts, the Air contain'd in the Blood and animal Fluids, muſt receive the ſame Impreſſion, and communicate it to that Blood, or to thoſe Fluids themſelves.

SCHO-

SCHOLIUM I.

FROM this Account of these perturbating Forces of the Sun and Moon, and how they come to affect the Blood and animal Fluids, any one who is but moderately acquainted with the Laws of Motion, will easily perceive, that such a Cause must have very considerable Effects upon animal Bodys, and such as ought by no means to be neglected, or escape the Notice and Care of a Physician. For,

1. THE whole Atmosphere, and consequently the internal Air contain'd in the Blood, being thus put into a violent intestine Motion, and that Motion being communicated to the Blood, the vital Fluid must in consequence of this be considerably heated and rarefy'd by the expansive Force of its included Air, and its Efforts to unbend and fly off: From which greater Heat and Rarefaction of the Blood, it must necessarily press more strongly upon the Sides of its containing Vessels. And because Fluids press *undiquaque*, the Blood by this lateral additional Pressure will be driven the more forcibly along the Axes of its containing Vessels, in its projectile Motion from the Heart; that is, the Velocity and *momentum motus* of the Blood will be increased.

2. FROM this greater Heat and Rarefaction of the Blood, ariſing from its increas'd expanſive Force and inteſtine Motion, there muſt enſue a greater fullneſs or plenitude of the Blood-Veſſels, while the ſame Quantity comes to take up a greater or larger Space.

3. BY this greater Heat and Rarefaction of the Blood, the Serum contain'd in it will be more intimately mix'd, and cloſely cohere with the *Craſſamentum* : and the Serum being thus as it were abſorb'd and detain'd in the *Craſſamentum*, the ſeveral Secretions, or the uſual Drain of the Serum by the Lymphaticks and glandular Pipes, will be proportionally leſſened, and a great Part of the Fluid which us'd to be drawn off by this means, will be detain'd in the Blood-Veſſels, and produce a greater Plenitude or Plethora of the Blood-Veſſels : and from hence any Hemorrhage or Efflux of the Blood from its proper Veſſels, will be augmented and promoted ; while all the other natural Diſcharges by the Glands and Lymphaticks, will for the ſame Reaſon and by the ſame Neceſſity be leſſen'd or diminiſh'd.

FROM ſuch a Cauſe as this therefore, 'tis manifeſt, that all Diſeaſes and ſymptoms of Diſeaſes, may be generated, increaſed, or aggravated, which proceed from, or are attended with a too great Plenitude of the Blood-Veſſels, and the conſequent Defect or Dimi-

Diminution of the Lymph and glandular Secretions. But what these Cases are in particular, and how to be distinctly and successfully apply'd to, must depend upon many other things not yet explain'd; which must therefore be dismiss'd here, and referr'd to their proper Places, in their natural and due Order.

SCHOLIUM II.

THE perturbating Forces of the Sun and Moon, having such Effects upon our Atmosphere and animal Bodys, as I have here observed in general, and shall farther explain hereafter; it might be of some use to Physicians, to enable them the better to judge of and apply to several very great and remarkable Crises of Diseases, if those Forces or their Effects were reduc'd to a *Calculus*; which might be dispos'd of in a Table to be read, to be recurr'd to, and inspected on all Occasions. Such a Table would be a sort of Astronomical Barometer or Hydrogage, by which the State and Disposition of the Air, and consequently of the Blood and animal Fluids, might be judg'd of, so far as it depends upon these general Causes; and which I am well assur'd, is in a much greater Degree than is commonly imagin'd. And tho the particular and appropriate Causes of Diseases, in the constitutional or accidental State and Disposition of the animal Fluids, are doubtless to be consider'd in the first Place,

as limiting, determining, and circumſtantiating the more general Cauſes; yet to neglect a Matter of ſuch Conſequence as the Influence and Impreſſion of the Sun and Moon would be found to be upon animal Bodys, is, I think, altogether unbecoming a Phyſician, as one who is ſuppoſed to be devoted to the Study of Nature.

PROPOSITION XXXIV.

BESIDES the general Force of Gravity, or the Weight of Bodys, as explain'd and apply'd in the foregoing Propoſitions, the very ſmall Particles of Matter, which conſtitute the larger Maſſes, are endu'd with a ſtrong attractive Force, which exerts it ſelf only at, or extremely near the Points of Contact; and vaniſhes at any greater Diſtance: Which Force or Power of Attraction, to diſtinguiſh it from that of Gravity, may be call'd the Force of COHESION; *it being that Force, by which the ſmall Parts of Bodys unite and cohere among themſelves.*

THIS appearance or affection of Matter, as reſpecting the ſmall conſtituent Parts of Body, is now generally known as evident and undoubted Fact; and is confirm'd upon the moſt numerous Experiments, made by the *Royal Society* and others: And therefore I ſhall only here mention a few unexceptionable Obſervations and Experiments,

by

by which the Truth of the Propoſition muſt appear in Fact.

'Tis well known, that the ſmall contiguous Parts of Bodys have ſome Degree more or leſs of Coheſion, ſo as to require a certain Force to diſunite and ſeparate them: and that this ariſes from the Attraction of the contiguous Parts, will be evident from the following Appearances of Fluids; where the manner of uniting and cohering may be plainly obſerv'd.

1. Every one knows, that any ſmall Portion of a Fluid ſeparated from a larger Maſs, will diſpoſe it ſelf into a little Sphere or Drop; which can only happen from the Attraction of the Particles, of which the Drop conſiſts: The Sphere being the only Figure, in which the mutually attracting Particles can come as near as poſſible to one another; and in which Form, with reſpect to any ſuch Power of Attraction, they will remain at reſt.

2. Let two ſmall *Spherulæ* of Quickſilver be placed upon an Horizontal Plane, near to one another; and while they are kept at a ſmall ſenſible Diſtance, they will both diſtinctly reſt, without being mutually affected. But as ſoon as they come at, or extremely near the Point of Contact, they will, by the attractive Power of their Parts,

run ſwiftly into one another, and unite in one larger Drop.

3. LET a glaſs Bubble, or any other Body that will ſwim, be immers'd in Water, and the Fluid will ſenſibly riſe above the common Surface, and as it were ſtick or adhere to the Sides of the immerſed Body. And the ſame will happen, if a Sphere of Braſs, Iron, or other ſuch Subſtance be immerſed in Quickſilver: Which plainly ſhews, that the Fluid and the immerſed Solid mutually attract each other; and that this Attraction, with reſpect to the contiguous Parts of ſuch Bodys, is ſuperior to the Force of Gravity.

4. LET one End of a ſmall open glaſs Tube, be immerſed in Water or any other Fluid, and the Liquor within the Tube will riſe to ſome ſenſible Height above the external Surface; the Reaſon of which is plainly this, that ſome part of the Gravity of the Fluid below, being taken off by the attractive Power of the internal concave Surface of the Glaſs, the Fluid within the Tube, by the external greater Weight or Preſſure, muſt aſcend ſo far as to compenſate for this Diminution of Gravity, by the Attraction of the Glaſs: And this Power of Attraction in the Tube, being found by Obſervation to be always in the reciprocal Ratio of the Diameter of the Tube, by leſſening the ſaid Diameter,

meter, or by taking or ſuppoſing Tubes ſtill ſmaller and ſmaller, Water, or any other Fluid, may be thus raiſed in ſmall open Tubes to any given or aſſigned Height. And ſince in this caſe the Fluid aſcends, contrary to the Force of Gravity, 'tis manifeſt this attractive Power in the ſmall Particles of Matter, muſt be ſuperior to the Weight or gravitating Force of the ſame Particles, towards the Centre of the Earth.

5. LET a Drop of Oil, Water, or other Fluid, be laid on a glaſs Plane perpendicular to the Horizon, ſo as to ſtand without breaking or running off; and let another glaſs Plane, inclined to the former, be brought to touch the Drop: then will the Drop break and aſcend towards the touching End of the Planes; and by altering the Angle of Inclination, the Drop may be directed to any part of the Horizontal Plane at pleaſure: which evidently demonſtrates the ſame Power of Attraction in the ſmall Particles of Matter, as in the foregoing Caſe of the Aſcent of Liquids thro ſmall open Tubes.

6. A GLASS or other Tube of any Diameter, fill'd with Sand, Aſhes, or other ſuch like porous Subſtance, and one End of the Tube ſo fill'd, being immerſed in Water, the Fluid will aſcend thro the Sand, Aſhes, *&c.* and fill all the Pores and Interſtices of the whole ſuperincumbent Column. For in this caſe, the

Pores

Pores and Interſtices between the ſmall contiguous Particles of the Sand, Aſhes, *&c.* effect the ſame thing with the ſmall Tubes in the Caſe foregoing; and the Fluid aſcends againſt the Force of Gravity, by the ſuperior Power of a different Attraction.

THESE Obſervations and Experiments, to mention no more here, are ſufficient to demonſtrate the Truth of the *Propoſition* in Fact; that there is ſuch a Power or Force of Attraction in the very ſmall Particles of Matter, exerting it ſelf at or extremely near the Point of Contact, that is much ſuperior to the Force of Gravity, and capable of determining thoſe ſmall divided Parts of Matter, in a different, or even quite contrary Direction to that of their own Weight.

COROLLARY I.

THIS Power or Force of Coheſion, in the very ſmall Particles of Matter, increaſes, as the Bulk and Weight of the Particles diminiſh. For ſince the Force of which we are now ſpeaking acts only at or near the Point of Contact, 'tis evident that the Moment or Quantity of Force, muſt be as the Quantity of Contact; that is, as the Denſity of the Particles, and the Largeneſs of their Surfaces. But the Surfaces of Bodys in proportion to their Soliditys, are as their Diameters, inverſly: For the Surfaces increaſe or decreaſe as the Squares, but the Soliditys as the Cubes of the Diameters. And conſequently

ſequently the ſmalleſt Particles having the largeſt Surfaces, in proportion to their Soliditys, and being capable of touching other Particles in more Points, will have the greateſt attractive Forces in proportion to their Weight. And hereby this Power of Attraction in the ſmall Particles of Matter, being increaſed as their Bulk and Weight are diminiſhed, ſuch ſmall Particles will be capable of receiving any given Direction by this Power of Attraction, juſt after the ſame manner as if they had no Gravity or Weight at all.

COROLLARY II.

UPON this Power of Attraction, the various Degrees of Coheſion in the Parts of Bodys plainly depend, and may eaſily be accounted for: this Coheſion being ever proportional to the Quantity of Contact, in the immediately contiguous Particles.

COROLLARY III.

FROM this Force of Coheſion, or Attraction of the ſmall contiguous Parts of Matter, all the Appearances of Elaſtick Bodys will follow, and may be eaſily explain'd. For where the ſmall contiguous Parts of any compound Body, which unite and ſtrongly cohere by immediate Contact, are, by any external Violence, as ſtriking, ſtretching, or the like, forced or driven from their Points of Contact to extremely ſmall Diſtances; after

after any ſuch external Force is taken off, the ſeparated Particles will by this Power of Attraction return to their prior Contact; by which means the Body will recover its former Figure. But if by any ſuch Force the contiguous Parts are ſeparated at too great Diſtances beyond their Power of Attraction, they will remain in that ſtate of Disjunction, and be uncapable of recovering their former Poſition and Contact; or, which is the ſame thing, the Spring or elaſtick Force of ſuch a Body, will be weaken'd, broken, or perhaps quite loſt.

COROLLARY IV.

If any Maſs of Matter, conſiſting of Parts which attract and cohere, be immerſed in a Fluid, and if the Parts of ſuch immerſed Matter be more ſtrongly attracted by the Fluid, than they are by one another; ſuch Parts will mutually recede from each other, and be equally diffuſed thro the Fluid: And this ſort of Solution, Separation and Diffuſion, may be conſider'd as a ſort of centrifugal Force in the Parts of the Body which are thus ſeparated and diffuſed; tho indeed, it ariſes only from the Exceſs of one Attraction above another. And this is doubtleſs the Cauſe of the Solution and Diffuſion of Salts in Water: For the conſtituent Particles of the Salts being more ſtrongly attracted by the aqueous Particles than by one another, their Coheſion muſt be broken, and the ſaline Parti-

Particles will recede from each other, with a Force proportional to the Excess of Attraction in the Parts of the Fluid. But whether the centrifugal or expansive Force of the Air, be owing to the stronger Attraction of another Medium, namely, the Medium of Light or elementary Fire, in which the Air is as it were immersed and retain'd, must be submitted to farther Enquiry.

SCHOLIUM.

No Observations or Experiments hitherto made, have been sufficient to determine the particular Law of Attraction in these small contiguous or cohering Parts of Matter; only thus much is certain, that this Force in receding from the Points of Contact, is diminish'd in a greater Proportion than that of the duplicate Ratio of the Distances, which is the Law of Gravity. For where Corpuscles attract each other in the reciprocal duplicate Ratio of their Distances, their Force of Attraction at any small assignable Distance, will be nearly the same as at the Point of Contact. But 'tis manifest from all Observation and Experience, that this Force of Attraction and Cohesion in the Parts of Bodys, is exerted only at or extremely near the Point of Contact; and at any sensible assignable Distance it vanishes, and has scarce any Effect at all.

Now

Now by *Prop.* 90, 91. *Lib.* 1. of *Newton's Principia*, if Corpuſcles attract each other mutually, in the reciprocal triplicate Ratio of their Diſtances, the Force of Attraction at their Point of Contact, or infinitely near it, will be infinitely greater than when they are at any given or aſſignable Diſtance; and according to this Law, which ſeems to obtain, at leaſt very nearly, in the ſmall contiguous and cohering Parts of Bodys, if this Force of Attraction at the Point of Contact be not infinitely greater than the Force of Gravity, at any given or aſſignable Diſtance, it will be infinitely leſs than that of Gravity.

But tho this Attraction in the cohering Parts of Bodys, be vaſtly greater than the Force of Gravity, yet it ſtill retains ſome finite aſſignable Ratio, and is not infinitely greater; becauſe the Parts of Bodys which have the ſtrongeſt Coheſion, may be ſeparated by a finite aſſignable Force: and conſequently this Force, which at the Point of Contact has ſtill ſome aſſignable Ratio to the Force of Gravity, at any given Diſtance from the Point of Contact, muſt quite vaniſh, or become infinitely ſmall.

PROPOSITION XXXV.

ELEMENTARY Fire and Air act and re-act mutually upon each other: that is, the Air is expanded and rarefy'd by Heat, which is the Action of Fire; and Fire

Fire is excited and put into its moſt violent and rapid Motion, by the Expanſion of the Air.

IT has been found, by the moſt numerous and accurate Experiments, that the Atmoſphere, or common Air, is a compreſſible and expanſive Fluid; whoſe Denſity is ever proportional to its Compreſſion: And therefore the centrifugal or expanſive Force of the Air, by which its conſtituent Parts endeavour to recede, or fly off from each other, muſt be in the reciprocal Ratio of their Diſtances, or in the direct ſubtriplicate Ratio of their Denſitys, by *Prop.* 18. *Lib.* 2. of *Newton's Principia.*

THIS is to be underſtood of the Air in its natural ſtate, and abſtracting from the Action of Light, or elementary Fire. But by the Action of this laſt Fluid, the centrifugal or expanſive Force of the Air may be vaſtly increaſed, beyond the foregoing Ratio of its Compreſſion and Denſity.

'TIS well known, that a ſmall Portion of Air, included in a Bladder or any cloſe Veſſel, may, by Heat or the Action of Fire, have its expanſive or centrifugal Force increaſed to a prodigious degree; and that by this means, any Quantity of Air may be ſuddenly and violently rarefy'd and expanded, ſo as to fill above twenty thouſand times the Space it poſſeſs'd before: and indeed, what elſe are all the ſurprizing Effects of Gun-pou-

der, or thoſe terrible Shocks and Convulſions which are call'd Earthquakes, but the natural Force and ſudden Expanſion of impriſon'd, heated, and rarefy'd Air?

On the other hand, Air loſes its Elaſticity and expanſive Force, in proportion as it is depriv'd of the Light, or elementary Fire which it imbibes and retains. For as the Elaſticity of the Air is increas'd in proportion to the elementary Fire it contains, and the Motion it is put into; ſo the total abſence of this Element, and the privation of its Action or Motion, would undoubtedly deſtroy that property of the Air, and leave it without any Elaſticity or expanſive Force at all. 'Tis evident likewiſe on the contrary, that Light or Fire loſes all its Motion or Action, and is preſently reduced to a ſtate of Reſt, as ſoon as it is depriv'd of Air. For ſuch is the incredible fineneſs and tenuity of this elementary Fluid, that it might eaſily, even in its moſt rapid Motion, penetrate the Pores of all Bodys, without making any Change or Alteration upon them, were it not for the Air which they contain; which being a groſſer Element, and being put into Action by Fire, is capable, by its vaſt expanſive Force, to diſſolve and ſeparate the moſt ſtrongly cohering Parts of mix'd Bodys.

I might here enumerate many particular Obſervations and Experiments, to evince this mutual Action and Re-action of elementary Fire and Air upon each other, and to

ſhew

ſhew the Neceſſity of both of them conjunctly, in order to the proper Efficacy and Effect of either: but the Matter is too plain in fact to need any long or tedious Proof; tho the manner of it may not perhaps be ſo eaſy to account for.

PROPOSITION XXXVI.

THE attractive coheſive Power of the ſmall Parts of Matter, as explain'd at Prop. 34. *is the univerſal Principle of Reſt, Concretion, and Fixation in Bodys; and the expanſive Force of heated Air, or the mutual conjunct Action of Fire and Air, as in the laſt* Propoſition, *is the univerſal Principle or natural Cauſe of Fermentation, Diſſolution, and Fluidity.*

UPON the different Proportion and Adjuſtment of theſe two oppoſite Forces, with reſpect to each other, the different internal Conſtitution, Texture, and Coheſion of Bodys, will plainly depend; and may accordingly be judg'd of and eſtimated.

BY the attractive coheſive Force, as at *Prop.* 34. where that alone ſhould be ſuppoſed to act, the conſtituent Parts of all compound Bodys, muſt be brought to their neareſt and greateſt Contacts, where they would remain at abſolute Reſt among themſelves, and be fix'd into ſolid cohering Maſſes; whoſe Soliditys, Denſitys, and Degrees of Coheſion, muſt in this be proportional to

the Quantitys of Contact in the immediately contiguous and cohering Particles: and therefore, by the ſole Preſence and Action of this attractive Force, 'tis manifeſt, that all Fluidity muſt be abſolutely deſtroy'd; all the Fermentation or inteſtine Motion of the Parts of compound Bodys muſt ceaſe, and all ſuch Bodys would remain fix'd and unchangeable in a State of internal Reſt and Solidity, without any Corruption, Solution, or Diſſipation of their Parts.

On the other hand, if this attractive coheſive Force be laid aſide, and the centrifugal expanſive Force of elementary Fire and Air, only conſider'd or ſuppoſed to act; the conſequence of this muſt be, that all Bodys, even the moſt compact and ſolid, muſt immediately be diſſolved, diſſipated, and diffus'd, ſo as to conſtitute one general and perfectly fluid Maſs, without any Diſtinction, or different Coheſion of Parts; which one general mix'd confus'd Fluid or Chaos, would yet ſtill be retain'd within a certain Orb or Sphere, by the Gravity or Weight of its Parts to their common Centre.

Having thus conſider'd the different Effects of theſe Forces, while one or the other of them is ſuppoſed to act ſeparately and apart, it will be now eaſy to ſhew, that all the different Conſtitutions and Coheſions of Bodys, their various degrees of Solidity and Fluidity, with the ſeveral Changes and Viciſſitudes they undergo, while the Corrup-

tion

tion and Diſſolution of ſome continually make way for the Generation and Concretion of others, in the beautiful Courſe and Order of Nature; muſt be all owing to the different Proportions and Adjuſtments of thoſe Forces, acting conjunctly under certain Conditions and Laws. Where theſe oppoſite Forces, in the Conſtitution of any Body or compound Maſs, are reſpectively equal; 'tis manifeſt, that ſuch Body or Maſs muſt continue in, or preſerve its preſent ſtate of Solidity, Fluidity, or Degree of Coheſion: ſince in this Caſe the Quantity of Contact muſt continue the ſame, and the conſtituent Parts can neither approach nearer to, nor recede farther from each other; that is, the Body, with reſpect to the internal Conſtitution, Texture, and Coheſion of its Parts, can admit of no change.

If the Power of Attraction prevails againſt the contrary centrifugal diffuſive Force, the conſtituent Parts will be brought nearer to each other, till they have obtain'd the greateſt Quantity of Contact they can admit of; and there they will reſt in a certain degree of Solidity, Fixation, or Force of Coheſion, proportional to ſuch Quantity of Contact.

But if the expanſive Force of the elementary Fire and Air, included in any Body or Maſs of Matter, prevails againſt the attractive Power of the contiguous Parts; the Parts which conſtitute any ſuch Body or

Maſs, muſt recede from their Points of Contact: and this happening thro all the Subdiviſions of which the Body or Maſs is capable, every ſmall Part muſt be divided and ſeparated into other ſmaller Parts, and theſe again into others, and ſo on, till we come to the firſt conſtituent Particles, which perhaps cannot be divided farther. And this Receſs of the Parts of Bodys from their Points of Contact, and their conſequent ſeparation and diviſion into their minuteſt conſtituent Particles or Corpuſcles, is what I call *Rarefaction*: and on the contrary, the approach of the Parts nearer to their Points of Contact, by the prevailing Power of Attraction and Coheſion, is what I underſtand by *Condenſation*. Now from the contrary Efforts of theſe two Forces, while the conſtituent Parts of Bodys, which have a continual *Niſus* or *Conatus* towards the Points of Contact, are forced off by the expanſive Power of the foregoing Elements, there muſt neceſſarily enſue an inteſtine Commotion, Colliſion, and mutual Struggle of the Parts among themſelves: that is, the Parts acted by two ſuch oppoſite Forces, will fly off and recoil, recede and accede, in proportion to the Strength and Energy of thoſe oppoſite Powers, till one or the other prevail, either to fix and condenſe the Body, or to diſſolve and diffuſe it: and in this Senſe I would be always underſtood, when I talk of the *Fermentation*, or inteſtine Motion of Bodys.

Now

Now where the attractive cohesive Force in Bodys, prevails against the contrary Power of the expansive Elements to any considerable degree, the most fluid and fluxile Bodys will be immediately fix'd and consolidated; as is evident in the Case of Water, and other Fluids turn'd into Ice; which happens thus: The elementary Fire and Air contain'd in the internal Constitution, or within the Pores and Interstices of such Fluids, being reduced to a state of Rest, there ensues a Sense of Cold, which is only the sensible Appearance or Indication of Rest in those Elements; upon which the attractive Power of the constituent Parts, prevailing against the contrary expansive Force, the Fluid is presently fix'd and consolidated, till the expansive Elements are again put into Motion; which reduces it to its former state of Fluidity.

On the other hand, by the Action of the expansive Elements, the most fix'd and solid Bodys are dissolv'd, and their Parts separated, broken and diffus'd; of which the Instances and particular Proofs are innumerable. But I shall only exemplify the general Case, from the single Instance of the Solution of Iron in *Aqua fortis*; because accounting for this, will explain the manner of all the rest.

'Tis well known, that any Parcels or Quantity of Iron, being immers'd in *Aqua fortis*, there will immediately ensue a strong sensible Fermentation, Effervescence, and

Ebullition of the Fluid, with great Heat, Fumes and Evaporations; during which, the ſolid compact Body of the Iron is perfectly diſſolv'd, divided into the minuteſt Parts, and equally diffus'd thro, and ſuſpended in the diſſolving Menſtruum: which, upon the Principles already laid down, is thus accounted for. The *Aqua fortis* immediately ruſhes into the Pores and Interſtices of the immerſed Iron, and is ſtrongly attracted and retain'd by the Parts of the Mineral: from whence the Air, which before poſſeſs'd and fill'd up thoſe Pores and Interſtices, having now leſs ſpace to expand, muſt be forcibly compreſs'd and condens'd; in conſequence of which Compreſſion and Condenſation, the included Air exerts its elaſtick Force, by a ſtrong *Conatus* to expand and fill the ſame Space as before; which being reſiſted by the attracted compreſſing Menſtruum, there muſt enſue a Fermentation or inteſtine Motion of the Parts; by which the elementary Fire contain'd in, and diffus'd thro the Subſtance of the Iron, being excited and put into Motion, heats and rarefys the Air, and encreaſes its elaſtick expanſive Force: and the heated rarefy'd Air, thus exerting a ſtronger elaſtick Force, communicates a more violent and rapid Motion to the included elementary Fire, till by the mutual Action of theſe Elements upon each other, the expanſive Force is increaſed beyond the attractive Power of the Parts of the Iron; and then the attracting

ting cohering Parts of the Mineral must necessarily recede more and more from their Points of Contact, and being separated and divided into the minutest Particles, will be dissolv'd and diffus'd in the *Aqua fortis*. For it must be here observ'd, that the Gravity or Weight of the exceedingly minute Particles, into which the dissolved Body is thus divided, being less than the attractive Force of the Parts of the Fluid or dissolving Menstruum, as at *Prop.* 34. this attractive Force of the Fluid suspends such extremely small Particles, and retains them in any given Position against their Force of Gravity. After the same manner, the Effects of all other dissolving Menstruums, as they depend upon the same Cause, are equally to be understood and accounted for. Upon the whole therefore, as the attractive cohesive Force of the small Parts of Matter in compound Bodys, is the universal Principle of Rest, Concretion, and Fixation; so the expansive Force of heated Air, or the mutual conjunct Action of elementary Fire and Air, is the universal Principle and natural Cause of Fluidity, Fermentation, and Dissolution.

SCHOLIUM.

From the Principles laid down in the three last *Propositions*, the ascent of Vapours or small Particles of Water, and other heavier Bodys in Air; the ascent of the Sap from the Roots thro the Bodys of Trees and Ve-

getables of all kinds; the Circulation of the Blood thro the extremely ſmall Capillary Arterys; the Paſſage of the Lymph or Serum thro the minute glandular *Tubuli*, and thro the vaſcular *Fibrillæ* which conſtitute the Bones, with other ſuch like Appearances and Phænomena of Nature, may eaſily be explain'd and accounted for.

THOSE who have endeavour'd to account for the aſcent of Water, Quickſilver, and Bodys ſpecifically heavier than Air, in the form of Vapour, only upon the Principles of Hydroſtaticks, have been forc'd to fly to mere precarious Hypotheſes, and ſuch as could never poſſibly be evinc'd as true in fact. But not to ſpend much time here in the Refutation of a falſe Hypotheſis, a little Conſideration will be ſufficient to ſhew, that this aſcent of heavy Bodys in the form of Vapour, cannot be owing to any Action of Gravity, Weight, or Preſſure whatever.

'TIS commonly known, that any Body being immers'd in a Fluid, if its ſpecifick Gravity be the ſame with that of the Fluid, it will every where reſt in it, or retain any given Poſition, without aſcending or deſcending. If the immerſed Body be lighter than an equal Bulk of the Fluid, the Body will aſcend to the Top, and remain in part above the common Surface, till a compound Column, conſiſting of the Fluid and the lighter Body together, be of equal Weight, or preſs equally on the Baſe or Bottom, with a Column of

of the pure Fluid. But if the immerſed Body be ſpecifically heavier than the Fluid in which it is immers'd, it muſt, by the neceſſity of its Weight, ſink to the Bottom, and remain there, unleſs it be rais'd and ſuſpended by ſome other Force. In the ſame manner, and for the ſame reaſon, if ſeveral Liquors, differing conſiderably in ſpecifick Gravity, and which cannot readily mix, be put into the ſame Veſſel, they will take place according to their Denſitys; the heavier remaining at Bottom, and the lighter aſcending towards the Surface.

Now all that is done by Rarefaction, or the expanſive Power of heated Air, as has been ſhewn, is only to force the ſmall Parts of Bodys farther from their Points of Contact, and thereby to ſeparate and divide them into other ſmaller Particles; but each ſeparated ſmall Particle will retain the ſame ſpecifick Gravity, with any greater Quantity or Portion of the ſame Maſs: and therefore, ſince any ſmall Particles of Water, which may be ſeparated by Rarefaction from a larger Maſs, are 14 times, and thoſe of Mercury 12000 times heavier than an equal Bulk or ſmall Portion of Air, they cannot poſſibly aſcend and be ſuſpended in it, by any Law of Weight or Preſſure. And yet we know, that even Mercury it ſelf, notwithſtanding its great Denſity, will, with the aſſiſtance of a little Heat, quickly run all into Vapour, and fly off in the Air.

But

But from that other Principle or Law of Attraction in the small constituent Parts of Bodys, demonstrated at *Prop.* 34. this Phænomenon will be naturally explain'd, and easily understood: for since this cohesive Force, by which the small contiguous Parts of Matter attract, unite with, and run into one another, increases as their Weight diminishes; that is, as the Surfaces increase in proportion to the Solidity's, or inversly as the Diameters; 'tis evident this corpuscular Attraction may be increas'd, and the Weight or Gravity diminish'd, till the latter vanishes, or becomes of no moment at all with respect to the former. In which Case, the very minute Particles of Water or other Fluids, separated and divided by Motion, Rarefaction, or otherwise, will be attracted, and as it were absorb'd by the contiguous Parts of the Atmosphere, as Water ascends in small Tubes, or thro a Column of Sand, Ashes, *&c.* for where this corpuscular Attraction takes place, it acts upon those very minute Particles, by attracting them any way, or every way indifferently, perpendicularly as well as horizontally; just after the same manner, as if they had no Weight or Gravity at all.

'Tis manifestly from the same Power or Principle of Motion, that the Sap rises from the Roots, thro the exceedingly minute vascular Fibres or *Tubuli*, of which the Trunks and Bodys of Trees and Vegetables are compos'd. For since a Fluid will rise in a small

open

open Tube of a given Diameter, to a given Height; and since this Height is by Observation ever in the reciprocal Ratio of the Diameter; 'tis plain that a Fluid, by this means, may rise in small Tubes to any given Height, provided the Diameter of the Tube be proportionally lessened.

After this, it can hardly be doubted, but that the Blood in animal Bodys circulates thro the Capillary Arterys, and thro the extremely minute glandular Strainers, and the almost infinitely small vascular *Fibrillæ* of the Bones, by the same Force, and upon the same Principle and Law of Motion. That this may be done without any thing of muscular Force and Motion, is evident from the Circulation of the Sap from the Roots, thro the solid Trunks and Bodys of Trees, in the Case just now consider'd: but tho the Circulation of the Sap be a thing evident in Fact, and plainly accounted for by this Principle or Law of corpuscular Attraction; yet it would be impossible by any Force of Impulse or Pressure whatever, to drive Water thro the Trunks or Bodys of Trees; and equally impossible must it be, to drive the Blood and animal Liquors, by any mere Force in the Muscles, thro such numberless and almost infinitely small *Tubuli*, which are infinitely divaricated, contorted, and branch'd out into all possible Directions.

But

BUT beſides the numberleſs exceedingly minute and infinitely divaricated *Tubuli*, which conſtitute the fleſhy Parts of an animal Body, and where only there is any muſcular Force or Action to be found; 'tis certain, in fact, that the animal Liquors circulate and paſs freely thro the minuteſt vaſcular *Fibrillæ* of the moſt ſolid and compact Bones: and to imagine that this Circulation and Paſſage of Liquors thro the Bones, is owing to the impelling protruding Force of the Muſcles, muſt, I think, be a Point of Belief almoſt beyond the Power of the moſt credulous.

THAT the Force and Action of the Muſcles have a principal ſhare in propelling the Blood and animal Fluids thro the larger and more open Veſſels, and likewiſe contribute by a gentle ſqueezing to empty the minute fleſhy *Tubuli* of their contain'd Fluids, I ſhall prove hereafter in its proper place: but that theſe extremely minute vaſcular Canals and Strainers ſhould be fill'd with their proper Liquors by any ſuch protruding Force of the Muſcles, is as impoſſible as it would be to propel, or drive Water from the Root thro the ſolid compact Body or Trunk of an Oak; which is what cannot be done by any Force of Impulſe, Protruſion, or Preſſure whatever.

PROPOSITION XXXVII.

THE expanſive or centrifugal Force of heated rarefy'd Air, ſeparates and diſſolves the Parts of ſolid Bodys; and intimately mixes

mixes and blends together the Parts of Fluids, so as to hinder the separation of their heterogeneous Particles.

THAT the expansive Force of the elementary Fire and Air, retain'd in the internal Constitution of Bodys, is the universal Principle of Corruption, Dissolution, and Fluidity in Bodys; and that this Force, when it prevails over the corpuscular Attraction, disunites and separates the cohering Parts of the most solid and compact Bodys, is sufficiently manifest, from what has been already prov'd in the two last *Propositions*; and that the same expansive rarefying Power, intimately mixes, blends, and unites the heterogeneous Parts of Fluids, and hinders their separation, is evident in Fact, from the commonly experienc'd and well-known Effects of Rarefaction and Fermentation in Liquors. For while this Rarefaction and Fermentation continues, Corpuscles of the most different Densitys and specifick Gravitys contain'd in the Fluid, are intimately mix'd and confusedly blended together, and no separation can be made.

BUT as the expansive Force lessens, and the corpuscular Attraction prevails, the denser and more solid Corpuscles unite, cohere, and form larger Corpuscles; which being separated from the Fluid, and subsiding or taking place according to their specifick Gravity, the Liquor refines and settles. After which Separation, Condensation, and Subsi-

dence, any Heat or Perturbation of Motion, which exerts and puts into Action the expanſive elaſtick Elements, will again raiſe the Sediment, and mix, confound, and blend the moſt different and heterogeneous Particles, as before: and while the denſer and more ſolid Corpuſcles, whoſe Attraction and Coheſion are greateſt, are by this means rarefy'd and enlarg'd, they abſorb or take up a great part of the Fluid, and render the whole Maſs thick, viſcid, and tenacious.

Philo-

Philoſophical Principles OF MEDICINE.

PART II.

Containing the more particular *Laws* which obtain in the Motion and Secretion of the vital Fluids, apply'd to the principal Diſeaſes and Irregularitys of the Animal MACHINE.

PROPOSITION I.

THE *Blood Globules, are ſpecifically heavier than the Serum, and conſiſt of Particles, which are endu'd with a ſtronger corpuſcular Attraction, and which receive and retain a greater degree of Heat.*

'TIS

'Tis commonly known, that the Blood of Animals, when view'd with a Microſcope while it circulates in its proper Veſſels, appears to conſiſt of numberleſs very minute red Globules, or *Spherulæ*, ſwimming in, and equally diffuſed thro a thin pellucid Water, Lymph, or Serum: Theſe two different Subſtances, tho of unequal ſpecifick Gravitys, yet while they continue to circulate in the Veins and Arterys, are equally mix'd and blended together, and kept from ſeparating by the Heat and Motion of the Blood, and the continued Action of the expanſive Element, as explain'd at *Prop.* 36, 37. *Part* I.

But any Quantity or Portion of this compound Maſs, being let out of its containing Veſſels and receiv'd in a Baſon or Porringer, and there ſuffer'd to remain at Reſt, that the Parts may take place according to their ſpecifick Gravitys; the Globules uniting by their corpuſcular Attraction, will ſink to the Bottom, and there form a *Craſſamentum* or coagulated Sediment, while the Serum will aſcend and ſwim above it. And this, which is a plain Matter of Fact and common Obſervation, evidently ſhews, that the Globules which form the *Craſſamentum* or Sediment, muſt be denſer or ſpecifically heavier than the Serum.

This is generally the Caſe in Fact, as every body knows; tho it ſometimes happens, that either by the Glutinoſity of the

Craſ-

Craſſamentum, ſticking to the ſides of the Porringer, or by reaſon of adventitious Bubbles of Air, which the Blood gathers while it flows from the Orifice, the *Craſſamentum* will be kept from ſubſiding, and ſeem to ſwim upon the Top of the Serum. But even in this Caſe, the Adheſion of the *Craſſamentum* to the ſides of the Veſſel being broken off, and the adventitious Air ſuffer'd to evaporate, the *Craſſamentum* by its greater Weight and Denſity will ſink to the Bottom, and the Serum remain above it, as before.

THE obſerving that one of theſe Globules, while it paſſes a ſmall Capillary Artery, will diſpoſe it ſelf into an oblong Spheroid, and recover its ſpherical Figure, as ſoon as it is got out of that narrow Paſſage; has induc'd ſome to conclude, that theſe Globules are thin Veſicles, or Bubbles blown up and diſtended with Air; and that the Reſtitution of the Globule to its former Figure, after it had been put out of it, muſt be owing to the elaſtick or expanſive force of the included Air. But this Reſtitution of the Globules, is plainly to be referr'd to another Principle; that is, to the corpuſcular Attraction of their conſtituent Parts, by *Prop.* 34. by which all ſuch ſmall Portions of Matter, provided they are ſoft and yielding, that is, fluid enough, will be reduc'd to little Drops or *Spherulæ*.

THUS let a Drop of Oil, or any other viſcid Liquor, be plac'd upon an horizontal Plane, and gently preſs'd perpendicularly by

another Plane, and the Drop by ſuch Preſſure will be reduc'd to an oblate Spheroid, and preſently aſſume its ſpherical Form again, as ſoon as the upper Plane is taken off, and the Preſſure remov'd; and this by the corpuſcular Attraction of its Parts, without any thing of Elaſticity or Expanſion by included Air: but that theſe Globules are not elaſtick Bubbles or Veſicles fill'd with Air, will be ſtill more evident from the following Obſervations.

1. Upon drawing off any Quantity of Blood into a Porringer, as the Blood cools, and the Globules unite by their mutual Attraction, in order to the Separation and Subſidence of the *Craſſamentum*, one may plainly perceive, eſpecially by the help of a Microſcope, that as the Globules preſs each other in their nearer Contacts, very conſiderable Quantitys of Serum will be forc'd or ſqueez'd out of their Pores and Interſtices, but no Air: which manifeſtly ſhews that their Cavitys were before fill'd and poſſeſs'd, not with Air, but with Water, Lymph, or Serum.

2. If theſe Globules are Bubbles or Veſicles blown up and diſtended with Air, let us ſuppoſe the external Veſicle or Shell to be a third Part of the whole Globule; which is a very liberal Allowance, with reſpect to Bubbles, whoſe Veſicles are commonly extremely thin: Then if the Globules, while diſtended and ſwimming in the Blood, be equal in Quantity to the Serum, which is a mode-

moderate Suppoſition, and agreeable to Experiments; before the Globules can ſink, the Air contain'd in them muſt evaporate and fly off, which being $\frac{2}{3}$ of the Bulk of the Globules or $\frac{1}{3}$ of the whole Maſs, it muſt follow from hence, that Blood when cold, and the *Craſſamentum* ſubſided, muſt loſe $\frac{1}{3}$ of its former Bulk, ſtill retaining the ſame Weight: that is, three Pints of hot Blood freſh drawn off, would, when cold, be reduc'd to two Pints; and its ſpecifick Gravity be increas'd in the ſame Ratio of 3 to 2. But 'tis certain that no ſuch thing happens in Fact, and that the Blood, when cold and ſettled, ſtill retains very nearly the ſame Bulk and ſpecifick Gravity.

Some ſmall difference there will indeed be, on the account of the Blood's Rarefaction while hot, and its Condenſation when cold; and which is common to the Blood with all other Liquors: but by this Cooling and Condenſation, the Blood increaſes its ſpecifick Gravity, only in the Proportion of 527 to 526, or thereabouts, as has been found by Experiments.

3. The Blood-Globules in a Vacuum, retain the ſame Size or Magnitude as in the open Air, as Experience teſtifys; but were they Bubbles or Veſicles fill'd with Air, they muſt either in this Caſe break by the great Expanſion of their included Air, or at leaſt be blown up to 70 or 80 times their former Bulk.

WHAT has been ſaid, is abundantly ſufficient to demonſtrate, that the Blood-Globules or *Craſſamentum*, is ſpecifically heavier than the Serum; and that conſequently being more denſe and compact, muſt conſiſt of Parts which are endu'd with a ſtronger corpuſcular Attraction: and as the *Craſſamentum* conſiſts of heavieſt and denſeſt Parts, ſo it muſt in conſequence be capable of receiving a greater Degree of Heat, and of retaining the Heat it once acquir'd longer than the Serum, which is of a more looſe and open Texture.

BUT for the particular proportional Denſitys, or ſpecifick Gravitys of Blood, Serum, *Craſſamentum* and common Water, the World is exceedingly indebted to the accurate Obſervations and Experiments of the Learned Dr. *Jurin*, of which he has given us an Account in the *Philoſophical Tranſactions*, N° 361. where by comparing and adjuſting his ſeveral Experiments, and taking a mean Proportion, he finds that the ſpecifick Gravitys of Blood, Serum, and common Water, are as 1054, 1030, and 1000 reſpectively. From whence again it muſt neceſſarily follow, that the *Craſſamentum* is ſpecifically heavier than the Serum; becauſe this being ſeparated from the Blood, leaves the Remainder ſpecifically lighter than the mix'd or compound Maſs.

THE

THE Blood-Globules in their natural ſtate, are plainly of a looſe, open, and ſpongy Texture, and contain in them a conſiderable Quantity of Serum; which being drawn off by Diſtillation, is found to be ſtrongly ting'd with Oil and volatile Salts, and its ſpecifick Gravity is to Water, as 1080 to 1000. But the ſpecifick Gravity of the dry'd *Craſſamentum*, after its contain'd Serum is drawn off, is as 1280: and by comparing Experiments, and taking a mean Proportion, the ſpecifick Gravity of the Blood-Globules in their natural ſtate, as determin'd by Dr. *Jurin*, is as 1126.

SCHOLIUM.

THIS greater ſpecifick Gravity of the Blood-Globules, is to be underſtood of a natural, ſound, and healthy State, and where they retain their due Proportion to the Serum; that is, where the *Craſſamentum*, when ſubſided and ſettled in a Porringer, is nearly equal to the Lymph which remains above it. But in a weak and languid ſtate of the Conſtitution and Blood, where the *Craſſamentum* bears but a ſmall Proportion to the Serum, its ſpecifick Gravity will be leſſen'd with its Quantity, as I have often found by Experience: for in Girls under a *Chloroſis*, and in hydropical People, whoſe Blood runs moſtly into Serum, I have ſometimes met with the remaining *Craſſamentum*, of equal ſpecifick Gravity with the Serum it ſelf, which would

continue to float freely about it, even after the Blood had ſtood and ſettled in a cold Place for a Day or two. But in Fevers, which come on by Depletion, or make their Attacks after any great Evacuations of the Serum; the Blood or mix'd Maſs, is often ſpecifically heavier than in its natural State; becauſe it contains a greater Proportion of the *Craſſamentum*, while the *Craſſamentum* it ſelf is ſpecifically lighter than before, as being more heated and rarefy'd.

PROPOSITION II.

THE Craſſamentum *or globular Part of the Blood, is a ſtanding or fix'd Quantity; and is not at all increas'd or diminiſh'd by the Augmentation or Diminution of the glandular Secretions.*

THAT all the natural Secretions conſiſt of certain Portions of the Lymph or Serum, drawn off from the Blood in the Arterys by very minute *Tubuli* or Strainers, which are too ſmall to admit the Blood-Globules, is moſt certain in Fact, and well known to every one who has the leaſt acquaintance with the Animal Oeconomy. Bloody Secretions, or ſuch as are ting'd and mix'd with the Globules, are always preternatural, and never happen but in a morbifick State. Since therefore all the natural Secretions are drains from the Serum, 'tis plain that the Serum of the Blood only, is increas'd or diminiſh'd in proportion

portion to the Secretions; while the *Craſſamentum* remains the ſame as to its abſolute Quantity, under any proportional Augmentation or Diminution of the glandular Secretions.

SCHOLIUM.

THIS Propoſition conſiders the Craſſament, only with reſpect to the Evacuations by Secretion, which may be increas'd or diminiſh'd, while the globular Part of the Blood as to its abſolute Quantity remains the ſame: But from other Cauſes, 'tis plain that the *Craſſamentum* may be increas'd or diminiſh'd in its abſolute Quantity, together with the Fleſh, Fat, and other more ſolid Parts of the Body. Thus in the Nouriſhment and Growth of Animals, the Craſſament ought to increaſe proportional to the Serum, for otherwiſe the due Conſtitution, Texture, and Conſiſtence of the Blood would be loſt; which muſt introduce a morbifick State. In weak and languid Conſtitutions, we ſee the *Craſſamentum* is often waſted and waſh'd off, together with the Fleſh and Fat, while the Serum abounds in too great a Quantity.

IN other morbid Caſes, the Serum runs off too faſt in the Secretions, while the globular Part remains in a very great and undue Quantity and Proportion: A remarkable Inſtance of which, I met with in a Gentlewoman, who, at about the Age of 50, dy'd of a dry Aſthma. She was continually af-

flicted for four or five Months with a melting wasting Heat, her Pulse being very small and quick; from a Pint of whole Blood, after it had stood a whole Night in a frosty Season, tho it had been very much condens'd with the Cold, and the *Crassamentum* was sunk to the Bottom of the Porringer in a hard compact Substance, yet there did not remain on the Top, which could be pour'd off, above $2\frac{1}{2}$ Ounces of Serum: and when Blood was taken from the same Gentlewoman in a warmer Season, it would scarce separate or throw off Serum enough to cover the Surface of the subsided *Crassamentum*, after it had stood and settled for a long time.

Now if we suppose the Blood-Globules, after their Subsidence, to retain their spherical Figure, the Serum contain'd within their Interstices, would be nearly equal in Quantity to the Globules themselves: But because the Globules when subsided must attract, and press upon each other, they must be suppos'd to touch, not barely in Mathematical Points, but in small physical Surfaces; and therefore, the Quantity of Serum contain'd within the Pores and Interstices of their touching Points, must be somewhat less; and consequently the *Crassamentum* must have been nearly equal to the Serum: and yet the Blood-Vessels in this case appear'd to be moderately full, and sensible Secretions were not large; from whence it must follow, that the absolute Quantity of the *Crassamentum* contain'd

tain'd in this Maſs of Blood, muſt at leaſt have been double to what is uſual in a ſound confirm'd ſtate of Health.

PROPOSITION III.

TO find the abſolute and relative Velocity of the Blood.

By the abſolute Velocity of the Blood, I here mean that which it obtains at the Heart, or in the *Aorta*, before its Ramification and Diviſion into Branches: and by the relative Velocity, I underſtand that which it obtains at any given Diſtance from the Heart, after any aſſignable number of Branches or Ramifications.

Now if the Sum of the tranſverſe Sections of the Branches and Ramifications of the *Aorta*, were every where equal to the Section of the main Trunk it ſelf, 'tis manifeſt, that the Velocity of the Blood in this Caſe muſt be every where the ſame as in the *Aorta*. But ſince it appears in Fact and by Experiments, that the Sum of the Sections of the Arterys, at every Diviſion, is greater than the Section of the common Trunk before the Diviſion; it muſt from hence follow, that the Velocity of the Blood will be diminiſh'd at every Diviſion, as the Canals enlarge, and in the ſame Proportion: and therefore the Ratio in which the Sections enlarge being given, the Ratio in which the Velocitys are diminiſh'd, will be likewiſe given.

For

FOR the abſolute Velocity: The Quantity of Blood thrown out of the left Ventricle, in a given time, being divided by the tranſverſe Section of the *Aorta*, will give the Length of the Canal, or the Space through which the Blood moves in the Time given.

THE left Ventricle, in its middle Size, is capable of containing between three and four Ounces of Blood: but it is not certain that this whole Quantity is empty'd into the *Aorta*, at every Contraction or Syſtole; and therefore I ſhall ſuppoſe, that during the Time of one Pulſation only, two Ounces of Blood is thrown into the *Aorta*; and that the Heart contracts 80 times in a Minute, and then there will be 160 Ounces paſs through the *Aorta* in a Minute.

AN Ounce of Blood is 1,65 cubick Inches, and conſequently 160 Ounces will be 264 cubick Inches. The Diameter of the *Aorta* is about 0,7 of an Inch; and conſequently its Section will be 0,4 of an Inch: and 264, the Quantity paſſing in a Minute, divided by 0.4, gives 660 Inches or 55 Feet, for the Length of the Canal, or Space deſcribed by the Blood in a Minute. And after the ſame manner may the Velocity of the Blood in the *Aorta* be determin'd, upon any other Suppoſition of the Quantity paſſing in a given Time.

FOR the relative or reſpective Velocity of the Blood, after any given Number of Branches or Ramifications of the great Artery;

tery: Let the Velocity in the *Aorta* be call'd *a*, and the Ratio of the Trunk to the Sum of the Sections of any two Branches, call *e*: then *a* being the Velocity at the Heart, the Velocity after the first Division will be ae; at the second Division ae^2, at the third ae^3, &c. consequently at the thirtieth Division the Velocity will be as ae^{30}.

Now the most usual Proportion which obtains between the Sections of the common Trunk, and the Sum of the Sections of its Branches, as Dr. *Keil* found by many Observations and Experiments, is that of $\frac{1000}{1259}$ nearly: upon which Supposition, let it be requir'd to find the relative Velocity of the Blood; for Instance, at the thirtieth Division the Logarithm of $\frac{1000}{1259}$ is 9,9065783; which multiply'd by 30, the Index of the Power of *e*, gives 7,1973490, to which the Number answering in the Tables is 0,001575; and consequently the Velocity at the Heart, is to the Velocity at the thirtieth Division, as 1 to 0,001575; that is, as 1000000 to 1575, or as 635 to 1. And therefore, if the Blood in the *Aorta* moves 55 Feet, or 660 Inches in a Minute, at the thirtieth Division it will move but little more than an Inch in the same Time. In like manner, at the fortieth Division the Diminution of Velocity will be as 5456 to 1; at the fiftieth as 46882 to 1; and at the hundredth Division as 2200000000 to 1 nearly. This is upon the Supposition, that the Sections are augmented

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thro all the Diviſions of the Arterys, in the ſame conſtant Ratio of 124 to 100 : but 'tis very probable, that a much leſs Ratio than this, muſt take place in the ſmall complicated Arterys ; and conſequently, that the Diminution of Velocity cannot be ſo great as this Proportion would ſuppoſe it, tho the number of Diviſions and Complications ſhould be much greater.

PROPOSITION IV.

MUSCULAR Motion is perform'd by the intrinſick Elaſticity of the nervous Fibrillæ, *contracting and reſtoring themſelves againſt the ſtretching Force of the circulating Blood.*

A MUSCLE is a Bundle of ſmall Blood-Veſſels, conſiſting of Arterys and their returning Veins, laid one upon another in very thin parallel Plates, running thro the whole Length of the Muſcle ; theſe Blood-Veſſels, or as they have been uſually call'd, longitudinal, red, and fleſhy Fibres, are every where at ſmall intervals, contorted and bound about with ſmall, tranſverſe, and ſpiral Ramifications and twinings of the Nerves, which Anatomiſts have commonly call'd, the white, ſpiral, and tranſverſe Fibres.

A MUSCLE thus conſtructed, has its two Ends, call'd the Tendons, faſten'd to two Bones, one of which is fix'd and the other moveable ; and by the Contraction of the Muſcle,

Muſcle, the moveable Bone is drawn upon its *Fulcrum* towards a fix'd Point. But before I proceed farther, it will be proper here to obſerve one remarkable Difference, between the Muſcles of voluntary, and thoſe of mere natural or neceſſary Motion, which is this; that all the Muſcles of voluntary Motion have their Antagoniſts, which act alternately in a contrary Direction, the one being ſtretch'd and extended, while the other is contracted by the Power and Command of the Will. But the Muſcles of bare natural neceſſary Motion, have their contracting, and extending or ſtretching Powers within themſelves, and need no Antagoniſts. Now I ſhall in the firſt place conſider what is in common to both theſe, as neceſſary and eſſential to all muſcular Motion whatever, whether voluntary, or barely natural and mechanical. In order to which, I ſhall here demonſtrate as an evident Matter of Fact, that all the nervous Coats and Fibres which enter into the Structure and Conſtitution of the Muſcles, are endu'd with an intrinſick Elaſticity, Spring, or Power of contracting and reſtoring themſelves, againſt a given Weight or Force by which they may be ſtretch'd; and, that this Elaſticity, or contractive reſtitutive Power, being a natural inherent Property of the Fibres themſelves, does not depend on the Mixture, Effervеſcence, or Rarefaction of any Fluids, Humours, or Liquors within the Body: this, I think, will abundantly appear

as plain in Fact from the following Conſiderations.

1. 'Tis manifeſt, that all the Veſſels in an animated Body, which conſiſt of flexible diſtractile Fibres, are in a ſtate of Tenſion; that is, they are both diſtended tranſverſly and ſtretch'd in Length, by the Quantity and *Momentum* of their contain'd Fluids: For let any ſuch Veſſel as a Vein or Artery, for inſtance, be cut tranſverſly, and the Blood being let out, or hinder'd from flowing to the Wound by a proper Ligature, the oppoſite Sides of the Veſſel will contract, and come nearly to a Contact about the Axis; while the two Ends will recede both ways from the Point of Section, by the contractive Power of the Fibres, and leave an intermediate Chaſm or gaping Wound: which makes it evident, that the Veſſel, while it remain'd intire and in its natural ſtate, was diſtended tranſverſly, and ſtretch'd in Length, by the Quantity and Moment of the contain'd circulating Blood; and conſequently, Contraction in all their Dimenſions, is the natural intrinſick Action of the Veſſels or Fibres themſelves: this Contraction therefore, is plainly the ſtate to which the elaſtick Fibres tend by a continual *Conatus*, and to which they are preſently reduc'd as their proper and natural ſtate of Reſt, as ſoon as they are freed from the diſtending ſtretching Force of the Fluids; and that the vaſcular or organical Parts of the Body, are proportionally inlarg'd

larg'd in all their Dimenſions by the Quantity and Moment of their contain'd Fluids, is farther evident from the Growth, or gradual Augmentation of Bulk in Animals. For every body knows, that by the increaſed Quantity and *Momentum* of the accumulated Blood and animal Fluids, the Veſſels in their natural State and Growth are inlarg'd in proportion every way; that is, ſtretch'd in Length as well as diſtended and widen'd in Breadth or Thickneſs: this therefore is the proper and natural Action of the Fluids, to diſtend and ſtretch the vaſcular Parts, and inlarge them in all their Dimenſions. Againſt the diſtending ſtretching Power of the Fluids, the ſolid muſcular *Fibrillæ* continually exert a contractive or reſtitutive Force, by which they are kept in their proper and natural ſtate of Tenſion, and without which they would immediately be relaxed, and become uncapable of any Action at all.

2. THAT this contractive Power of the muſcular Fibres, is a natural intrinſick Property of the Fibres themſelves; and that it does not depend on any Mixture, or mutual Action of Fluids within the Body, is evident from hence, that theſe Fibres retain the ſame Property, after they are taken out of the Body and dry'd; as we ſee in Thongs, Cat-gut, and other ſuch-like Cords or Strings, cut out of the muſcular Coats and Skins of Animals, which may be ſtretch'd out to a conſiderable Length beyond their natural State;

and

and when the ſtretching Force or Weight is taken off, they will immediately contract again, and recover themſelves by their own native intrinſick Spring.

3. WHILE a Muſcle contracts, the Blood is forcibly ſqueez'd out of it, and during its ſtate of Contraction, it is more hard, compact, and ſolid than before; that is, it contains leſs Blood and Fluid in it when contracted, than when it is ſtretch'd and extended: which plainly ſhews, that this Contraction cannot be made by the addition of another Fluid from the Nerves, mixing with Blood in the Muſcles.

'TIS well known, in Blood-letting, where a Section has been made in the Cephalick Vein, if the Blood does not flow free enough from the Orifice, the Velocity of the effluent Blood will be much increas'd and promoted, by clinching the Hand of the ſame Side, and bringing the Muſcles of the *Carpus* into a ſtrong Contraction: if this Contraction be long continu'd, the Velocity of effluent Blood will be ſenſibly abated by ſuch continual bent; but if the Fibres are unbended, and the Muſcles contracted again, by turns, the increas'd Velocity and Impetus of the Blood from the Orifice will be reſtor'd, and may be kept as long as we pleaſe. This is the Matter of Fact, and which happens thus; The Blood with which the Muſcles of the *Carpus* are fill'd and diſtended, while they are ſtretch'd and dilated, being forcibly compreſs'd and ſqueez'd

ſqueez'd out by the Contraction, is ſent directly into the Subclavian Vein, from whence it flows out at the Orifice, and increaſes the Velocity.

If the Contraction be long continu'd, the Velocity will abate, and be but little, if at all, promoted; at moſt, no farther than what may be done by a ſmall Quantity of Blood, which being ſuſpended from entring the Muſcles of the *Carpus*, now finds an eaſier and more open way thro the Orifice. But if thoſe Muſcles be alternately contracted and extended, the increas'd Velocity of the Blood thro the open Vein will be kept up; becauſe in this Caſe there is not only an increaſed Quantity of Blood ſent to the Orifice, but a continual new Impetus given it by the contracting compreſſing Nerves. Every body knows the Power of Exerciſe, or any brisk voluntary Motion, in raiſing the Pulſe and increaſing the Velocity of the Blood; and how this comes about, is very evident from this Principle: for the Blood, forc'd with a new Impetus thro thoſe Muſcles, by their repeated ſtrong Contractions, muſt communicate its Motion to the reſt of the Blood, till the Pulſe gradually riſes, and the Heat diffuſes it ſelf, as we find in Fact.

But the moſt convincing experimental Proof of this, as true in Fact, is from what may be obſerv'd in the Heart of a Dog, whoſe Thorax has been laid open, ſo as to give us a diſtinct view of that famous Muſ-

cle in its curious and wonderful Motion, while the Animal is ſtill alive.

In this Caſe one may obſerve, that the Heart while it is in its Diaſtole, appears of a very red and florid Colour; 'tis ſenſibly ſoft and yielding to the Touch, the vital Fluid glows in it and ſhines thro it; and in ſhort, all the Circumſtances ſhow, that in this ſtate the Muſcle is fully repleniſh'd and diſtended with Blood: but as ſoon as it begins to contract, one may obſerve the Blood with an increas'd Velocity, flowing out of its whole Subſtance, thro the Coronary Veins into the *Auricles*; and while the Blood thus ruſhes out, by the Compreſſion of the contracting nervous Fibres, the Heart manifeſtly changes its former red and florid, into a much more pale and livid Colour; it is ſenſibly more compact and ſolid to the Touch, and every Circumſtance concurs to evince, that in its Syſtole it contracts inwardly into its own Subſtance, and is more denſe, or takes up leſs ſpace than before.

The Syſtole being over, and the Heart returning to its Diaſtole, the Velocity of the Blood thro the Coronary Veins is abated, and the Muſcle recovers its former Redneſs, Floridity and Softneſs: from whence 'tis manifeſt, that in this Caſe the Blood ruſhes into the whole Subſtance thro the Coronary Arterys, and inflates and ſtretches the Blood-Veſſels, in order to bend or ſtrain the Nerves for the next Contraction.

4. The

4. THE common Hypotheſis, which derives a new additional Fluid from the Nerves, to be mix'd with the Blood in the Muſcles, in order to their Inflation and Contraction, is not only contrary to all the foregoing evident Facts, but likewiſe plainly inconſiſtent with the Circulation of the Blood. For 'tis manifeſt by what has been here ſaid, that the Blood in the Muſcles, during their Contraction, is ſo far from receiving any additional Fluid from the Nerves, that its Quantity is very much diminiſh'd, while it is ſqueez'd out with an increaſed Impetus and Velocity, by the compreſſive Force of the contracting reſtoring Nerves.

BUT beſides this, the common Doctrine concerning muſcular Motion is plainly inconſiſtent with the Circulation of the Blood, and with all the known eſtabliſh'd Laws of Nature in the Animal Oeconomy: For 'tis here ſuppoſed, that the longitudinal Fibres, as they are call'd, which conſtitute the main Body of a Muſcle, are divided at ſmall Diſtances by tranſverſe Fibres, as ſo many Ligatures, into innumerable little Cells, *Veſiculæ* or Bladders, communicating with the Blood-Veſſels and Nerves; in which ſmall Veſicles or Bladders, the Blood and nervous Fluid mixing, preſently run into a Fermentation; and by their Rarefaction and Expanſion, ſwelling and blowing up the little Veſicles, the Body of the Muſcle is hereby inflated and diſtended, or increaſed in Thick-

neſs while it is ſhortned in Length. This is the common Hypotheſis, at leaſt ſo far as I am able to comprehend it, and which I take to be incumber'd with ſeveral inſuperable Difficultys. For,

In the firſt Place, no ſuch Fluid in the Nerves could ever be found, as being mix'd with the Blood, would occaſion any ſuch Fermentation, Rarefaction, or Expanſion, as is here ſuppos'd: and yet this is a Matter which certainly ought to have been well clear'd in Fact, before it had been receiv'd as a Law of Nature, and made uſe of to account for other Phænomena; eſpecially before ſo great a ſtreſs had been laid upon it, in accounting for almoſt all Diſeaſes.

But ſuppoſing theſe muſcular Cells, Veſicles, or little Bladders to be inflated, as is here imagin'd, by the expanſive Force of an included Fluid; yet no ſuch Effect could follow, as ſhortning the Muſcle in Length and ſwelling it in Thickneſs: but the Conſequence in this Caſe muſt be, that the Muſcle would be lengthned as well as thickned; that is, it muſt increaſe its Dimenſions proportionally every way, which is the proper and natural Action of the Fluids upon the Solids, as has been ſhewn already.

Perhaps it may be ſaid, that theſe Strings of Veſicles or little Bladders, when the Muſcle is ſtretch'd or extended, are drawn into oblong Spheroids; but when they are inflated by the Mixture of the nervous Fluid with the Blood, they

they are reduced to a ſpherical Figure, by which means their Axes will be ſhortned, and their conjugate Diameters enlarg'd. But ſince the Veſicles muſt be allow'd to be ſoft, flexible, diſtractile, and equally yielding every way; and ſince an included expanſive Fluid muſt preſs its containing Veſſels equally every way, that is, in the Direction of its Axis and conjugate Diameter equally; 'tis manifeſt that any Veſſel, notwithſtanding ſuch Preſſure or Diſtenſion, muſt retain its natural or proper Figure; and being equally diſtended and ſtretch'd in all Directions alike, muſt proportionally be inlarg'd in all its Dimenſions. But there is one thing farther which muſt intirely overthrow this Hypotheſis, and that is, that no ſuch Rarefaction or Expanſion in the Muſcles can poſſibly happen, without giving an invincible Check, or putting a ſtop to the Circulation of the Blood. For ſince the Blood circulates continually and freely thro theſe muſcular Veſicles, by the Hypotheſis, 'tis evident that theſe Veſicles muſt be continu'd Canals with the Blood-Veſſels; for otherwiſe there would be a continual Extravaſation of Blood, which muſt ſoon put an End to the Circulation, and to the Life of the Animal. And ſince the Blood circulates freely thro theſe muſcular Cells or Veſicles, 'tis plain that as ſoon as ever they begin to inflate and blow up, the Blood muſt be immediately puſh'd forward with an increas'd Velocity in the Courſe of its Circula-

tion; which must necessarily prevent any such Inflation, Tumefaction or Distension in the Muscles. Before these Vesicles therefore can be blown up and distended in the manner that is suppos'd, the Exit of the distending rarefying Fluid must be hinder'd; that is, the Circulation of the Blood must be stopt. And if any one should doubt of this, let him try whether he can blow up a Bladder or other Vessel that is open at both Ends, and where the expansive Fluid has as free an Egress as Ingress. But if this cannot be done, it must be equally impossible to inflate the Muscles according to the common Hypothesis, while there is an open free Communication with the Arterys and Veins.

THESE things premised, the natural mechanical Action of a Muscle will be now easily understood and explain'd: for 'tis evident from the Structure and Constitution of a Muscle, as already describ'd, that upon the Contraction of transverse and spiral Fibres, which are the Ramifications and Twinings of the Nerves, the longitudinal, red, and fleshy Fibres or Blood-Vessels, which constitute the main Body of the Muscle, must be squeez'd, contorted and drawn together, as being compell'd to follow the Motion and Direction of these contracting elastick nervous Cords; by which means the Blood-Vessels being straitned and compress'd, must be forc'd with some impetuosity thro the Muscle, and propell'd forward in the Course

backward against]

of

of its Circulation. Now if the Blood ſhould hereupon ſtop, and return no more to the Muſcle, 'tis plain that the Muſcle muſt for ever remain in this contracted State, as its proper and natural ſtate of Quieſcence to which it tends; and where it would reſt, by the intrinſick elaſtick Power of theſe nervous contracting Fibres: But the Blood having receiv'd a freſh Impetus by the Contraction, and returning upon the Muſcle in the Courſe of its Circulation, ruſhes into the Blood-Veſſels, which being inlarg'd in all their Dimenſions by the Force and Impulſe of the returning Blood, the tranſverſe and ſpiral nervous Fibres muſt be hereby ſtretch'd, and the Muſcle extended; by this means the Blood-Veſſels being brought to their natural and due Extent and Capacity, and conſequently the ſtretching diſtending Force of the Blood ceaſing or diminiſhing, the contractive Power of the Nerves will in that ſtate begin to act again, and reſtore themſelves with the ſame Force by which they were ſtretch'd and extended; till the returning propell'd Blood re-enters the Muſcle, and ſtretches it again, as before deſcrib'd. Now 'tis evident that theſe two Counterforces being once thus adjuſted and æquipois'd, this alternate Contraction and Extenſion muſt be continu'd neceſſarily and mechanically, without any Dependence upon Will or free Agency, till the Æquilibrium be broken, and the Motion ſome way or other preternaturally interrupted

and ſuſpended. And from hence appears very plainly what has been obſerv'd before; that every Muſcle of more natural involuntary Motion, has its contracting and ſtretching Powers within it ſelf, or in its own Structure and Conſtitution, without needing the aid and aſſiſtance of antagoniſt Muſcles.

But where the Bones and Members are to be mov'd with any great Force in contrary Directions, by the command of the Will, the Author of Nature has every where in this Caſe provided the Animal Machine with antagoniſtical Muſcles, one of which is contracted while the other is extended: And how the Matter ſtands in this Caſe with reſpect to muſcular Motion, or how this voluntary Motion differs from that which is natural and neceſſary, I ſhall now proceed to ſhew.

Now ſince the Muſcles of neceſſary and voluntary Motion, have plainly the ſame internal Structure and Conſtitution, with reſpect to the Twinings and Ramifications of the Nerves, with the Blood Veſſels; 'tis manifeſt they muſt have the ſame neceſſary mechanical Action: that is, they muſt be alternately ſtretch'd and extended, contracted and compreſs'd, in conſequence of their Organization and Structure; whether there be ſuppos'd to be any Interpoſition of the Will, or Influence and Impreſſion of the Mind upon them or not.

And

And here with reſpect to this neceſſary and barely mechanical Action of the Muſcles, thoſe which are intended for voluntary Motion, and which are therefore provided with Antagoniſts, are ſtretch'd and extended, or contracted and compreſs'd, together and at the ſame time: by means of which conjunct and uniform Action of the ſame pair of Antagoniſts, theſe Muſcles, ſo far as they act naturally, neceſſarily, and independent on the Will, are always kept *in Æquilibrio*, as being continually and alternately impreſs'd with two contrary equal Forces.

But here the Author of Nature has put it into the Power, or under the Command of the Mind, by a Volition, Preference, Choice, or free Determination, to alter this *Æquilibrium*, and turn the Balance one way or the other at pleaſure: that is, the Mind by willing, directing, or determining it, can impreſs the nervous elaſtick Cords, or *Fibrillæ* of any Muſcle which has an Antagoniſt, with a certain Stimulus, Irritation, or compreſſive Energy, by which the Muſcle ſo impreſs'd is brought into a ſtrong and forcible Contraction, againſt the contrary much weaker, and merely mechanical Force of its antagoniſtick Muſcle.

This is evidently ſo in Fact, but the manner of it can no more be explain'd than the Union of Soul and Body, of which this is one of the Laws. 'Tis plain in Fact, that external Objects, by ſtriking and impreſſing

the Organs of Senſation with a certain Stimulus or Irritation, excite their peculiar and appropriate Ideas in the Mind; and on the other hand, the Mind by willing, directing, and determining it, can impreſs the Nerves with ſtimulating, contracting, and compreſſive Force upon the Blood-Veſſels, by which the antagoniſtick Muſcles are drawn in their reſpective contrary Directions at pleaſure. Now the beſt way of accounting for this, is, doubtleſs, to reſolve it into the Will and Power, or continual Preſence and Action of the firſt Cauſe, who has eſtabliſh'd ſuch a Law, and continues it in force and execution. They who do not like this, may by Imagination create as many intermediate Cauſes as they pleaſe; but they muſt either come at length to a firſt Cauſe, and ſo take all this Round to no purpoſe, or elſe run up the account of Matters *in Infinitum*, without ever coming to a firſt Cauſe; or, which is the ſame in the iſſue, ſuppoſe every thing to be Effect without Cauſe, or without any original independent active Power or Principle of Energy and Motion: which muſt reduce Religion and Philoſophy to the ſame deſperate State, and deſtroy all the Principles of Reaſon, as well as of Virtue and moral Conduct.

COROLLARY.

From hence we may conclude the Inſufficiency and Unuſefulneſs of the ſeveral labour'd and learned Computations which have

have been given us of the muſcular Force of the Heart, as if this was the only, or at leaſt the chief Cauſe of the Circulation of the Blood.

For ſince theſe muſcular elaſtick *Fibrillæ* are every where twin'd and interwoven with the Blood-Veſſels, not only in the Muſcles ſtrictly ſo call'd, but alſo in the Glands, the muſcular Coats, and univerſally wherever any Blood-Veſſels are to be found: and ſince every ſuch elaſtick Fibre, being ſtretch'd, muſt by its Contraction compreſs the Blood-Veſſels, and ſqueeze forward the Blood; 'tis evident that the whole Force by this means impreſs'd upon the Blood, muſt be the Sum of the Forces of all the elaſtick Fibres taken together, and conſequently that the Heart in this Caſe can contribute but its ſhare; and that with reſpect to other Muſcles, in proportion to its ſtrength: and therefore, to attribute the Circulation of the Blood to the ſole Impulſe and Protruſion of the Heart, muſt be extremely Unphiloſophical and Immechanical, as being contrary to the plain and obvious Laws of Animal Motion.

But neither is this muſcular Action of the elaſtick nervous *Fibrillæ*, and their Compreſſion upon the Blood-Veſſels, the ſole Cauſe of the Circulation of the Blood; for we know that Liquors may freely circulate thro exceedingly fine and almoſt infinitely ſmall Tubes, without any muſcular Force or Action at all; as is the Caſe in Trees and Vegetables

of

of all kinds, and likewiſe in the Paſſage of the proper Aliment and nutritious Liquors thro the Bones and moſt ſolid Parts of Animal Bodys, where no muſcular Action can be conceived; and which ſort of Circulation or Paſſage of Liquors, muſt therefore be aſcrib'd to that other Principle or Law of Motion, *i. e.* the corpuſcular Attraction, as explain'd and demonſtrated, *Prop.* 34. *Part* I.

PROPOSITION V.

THE Nerves are repleniſh'd with a ſoft oily Liquor, not much unlike the White of an Egg; ſerving to cool, moiſten, and lubricate the nervous elaſtick Fibres.

THAT the cortical Part of the Brain is glandulous, and contriv'd for the Secretion of a certain Liquor from the Blood, and that the Nerves take their original in numberleſs ſmall Pipes or *Tubuli* from theſe Glands, is plain Matter of Fact, and confirm'd by the concurrent Obſervation and Experience of all Anatomiſts: And that ſuch a Liquor as here deſcrib'd, is likewiſe actually found in the Nerves, and preſently diſcharges it ſelf when any Nerve is cut or wounded, is equally true and undeniable in Fact.

THE firſt part of this *Propoſition* therefore, with reſpect to the actual Exiſtence of ſuch an oily lubricating Fluid in the Nerves, being evident in Fact, muſt be allow'd as a thing paſt all diſpute. And as to the latter part

part of the *Propoſition*, the Neceſſity of ſuch a Fluid or Liquor to the Purpoſe here aſſign'd; it muſt be alſo equally plain and evident, to any one who will conſider the Nature of ſuch elaſtick ſpringy Fibres, of which the internal Subſtance of the Nerves conſiſts: for 'tis well known, that all ſuch elaſtick Fibres require a due Degree of moiſtning, ſoftning and lubrication, in order to retain their Flexibility and capacity of Extenſion; when they are over-heated and dry'd, they contract immediately, and become ſo ſtiff and inflexible, as to be uncapable of ſtretching by any ordinary Force.

Such ſtiffneſs, hardneſs, and inflexibility, is what always, in Fact, happens to a Nerve, when this animal Oil, or ſoftning lubricating Liquor, is by any means obſtructed and intercepted; the Nerve depriv'd of it immoderately contracts, hardens and dries up, ſo as to loſe its proper and natural Action.

On the other hand, where the Nerves are too much ſoak'd and drench'd with this oily lubricating Liquor, they preſently grow ſoft, lax, and flabby, and will eaſily yield to any the leaſt ſtretching Weight or Force, without any Capacity of contracting and reſtoring themſelves. And theſe being the two moſt common and remarkable Diſeaſes of the Nerves and elaſtick Fibres, ariſing either from the Exceſs or Defect of this animal Oil or nervous Fluid; I preſume the *Propoſition*, from what has been here ſaid, muſt be thought ſuffi-

ſufficiently confirm'd ; unleſs it be with thoſe who from the Credit of a bare Hypotheſis, without any Proof, have aſcrib'd to this animal Oil or nervous Fluid, an Office, as they imagine, of much greater importance, under the Name of *Animal Spirits* ; while it has been thought to be the main Cauſe of muſcular Motion, by mixing and rarefying with the Blood in the Muſcles, thereby diſtending and widening them tranſverſly, while they are contracted and ſhortned longitudinally.

But having already, as I think at leaſt, eſtabliſh'd a true Theory of muſcular Motion, upon evident Facts, and ſhew'd the Falſhood of this Hypotheſis, as contrary to the Laws of Nature, and the Motion of the Animal Fluids ; I ſhall here ſpare my ſelf the Trouble of any farther Confutation.

PROPOSITION VI.

THE Lungs are a Muſcle ; in which the Air performs the ſame Office with the Blood in other Muſcles.

The *Trachea*, as is commonly known, having enter'd the Cavity of the Thorax, divides it ſelf into two main Branches ; each of which ſends forth an infinity of ſmaller Branches and Ramifications, which are complicated and interwoven into innumerable *Veſiculæ* or little Bladders, all communicating with the common Trunk. Each Lobe of the Lungs is divided into a certain number

of Lobules, and each Lobule into these extremely minute Vesicles. The Blood-Vessels being the Branches and Ramifications of the pulmonary Artery and Vein, are dispers'd and interwoven in a very curious and fine Network, with these bronchial Lobules and Vesicles; a Branch or Ramification of the pulmonary Artery, with its corresponding Vein, attending every Division and minutest Subdivision of the *Trachea*.

EACH Lobule consisting of the Branches and Ramifications of the *Trachea*, attended with those of the pulmonary Artery and Vein, is wrapt up in a common Coat or Tegument; and the Lobes which they thus constitute, are likewise inclos'd and wrapt up in their common Coats or Coverings, by which they are fastned, compacted, and bound together.

FROM which Structure and Contrivance of this curious Organ, 'tis manifest that the Blood-Vessels must necessarily follow the Motion and Direction of the bronchial *Vesiculæ* or Air-Bladders, both which must be either extended and divaricated, or contracted and compress'd at the same time.

THUS when upon raising the Breast, the Air rushes in thro the *Trachea*, and distends or blows up the *Vesiculæ* which communicate with the common Trunk; 'tis evident the Blood-Vessels to which these *Vesiculæ* are fasten'd, must at the same time be stretch'd, distended and divaricated: by which means, there will be an open and free Passage made for

for the Blood from the right Ventricle, to flow in, fill up, and diſtend all the Branches of the pulmonary Artery and Vein. But when the Thorax ſubſides, the cartilaginous annular Bandages of the Bronchia, the muſcular Coats of the Lobules and Veſicles, together with the muſcular Coats and Fibres of the Blood-Veſſels, at the ſame time contract; whereby the Blood is forcibly propell'd and ſqueez'd out thro the correſponding Branches and Ramifications of the pulmonary Vein, into the left Ventricle of the Heart; by the Contraction of which, it is driven into the *Aorta*.

All this is obvious to the Sight, in a living Dog, whoſe Thorax has been laid open; where 'tis viſible, that when the Lungs are blown up and diſtended with Air, the Blood-Veſſels are at the ſame time ſtretch'd and divaricated, and the Blood ruſhing in thro the Branches of the pulmonary Artery, the whole Subſtance of the Lungs becomes red, florid, and diſtended with Blood, while the Veſicles of the *Trachea* are diſtended with Air: but when the bronchial *Tubuli* and Veſicles contract, the Breaſt ſubſides; the whole Subſtance of the Lungs being compreſs'd, grow more compact, and the Blood is forcibly driven thro the Branches of the *Vena pulmonaris*, into the left Ventricle of the Heart; and in ſhort, every thing happens here after the ſame manner, as has been obſerv'd, in the Syſtole and Diaſtole of the Heart

it

it ſelf: from whence 'tis ſufficiently evident, that the Lungs act as a Muſcle; and that the Air in the ſmall Tubes and Veſicles of the *Trachea*, performs the ſame Office with the Blood in other Muſcles.

Now ſo far as Reſpiration is purely mechanical and neceſſary, the Muſcles employ'd in it, have their contracting and ſtretching Powers within themſelves, ſo as to ſtand in need of no Antagoniſts: And after what manner the Quantity and Moment of the circulating Blood, act as a Ballance or Counterpoiſe to the contracting reſtoring Power of the Nerves, has been ſhewn already. But becauſe this Act of Reſpiration is likewiſe partly voluntary, and the Muſcles employ'd in it are evidently in ſome meaſure under the Command of the Will; it will be neceſſary to conſider this Matter a little farther, and to ſhew what are the true and real antagoniſtick Powers in this voluntary Action.

That the intercoſtal Muſcles and Diaphragm, by which the Ribs are raiſed, and the Cavity of the Thorax enlarg'd, have no proper Antagoniſts within the Body, is well known and commonly allow'd: and yet without ſome ſuch antagoniſtick Power, the Act of Reſpiration muſt be purely mechanical and neceſſary, and could not be at all ſubject to the Command and Direction of the Will. Here therefore the Author of Nature, by an extraordinary Contrivance, has made the Lungs (thro the Interpoſition and con-

junct Action of the common Air or Atmosphere) the proper antagoniſtick Power to the intercoſtal Muſcles and Diaphragm. And how this is brought about and effected, will be plain from what follows.

'Tis commonly known, that the external Air or Atmoſphere preſſes upon the Surface of an animal Body, as well as upon the Surfaces of all other Bodys immerſed in it: and that this Weight or Preſſure upon a given Surface, is equal to the Weight of a Column of Quickſilver, whoſe Baſe is the given Surface, and its Altitude 30 Inches. Now the Weight of a cubick Inch of Mercury is 8,102 Ounces *Avoirdupois*; and therefore the Weight of a Column of Mercury, whoſe Baſe is one ſquare Inch, and its Altitude 30 Inches, is 243 Ounces. And if we ſuppoſe the whole Surface of the Body to contain 15 ſquare Feet, or 2160 Inches, the Weight of Air preſſing upon the Surface of ſuch a Body will be 524680 Ounces, or 32780 Pounds Weight. The Thorax, which is rais'd and depreſs'd alternately in Reſpiration, may be conſider'd as a Cylinder, whoſe Circumference is 40, and its Altitude 8 Inches; of which Cylinder, the convex Surface will be 320 Inches; and conſequently the Preſſure of the Air upon it, will be equal to 4860 Pound Weight.

It muſt be obſerved here, that the reaſon why ſo great a Weight or Preſſure upon the Surface of the Body has no ſenſible Effect,

is

is this; that the internal Cavitys of the Body, and the Interſtices of the Blood and animal Fluids, being all fill'd with Air of the ſame Force and Spring with the external Air, while theſe two equal Forces in contrary Directions are kept *in Æquilibrio*, they will mutually ſupport and ballance each other; and every thing will remain in the ſame State either of Motion or Reſt, as if there was no ſuch Weight or Preſſure at all: But when once the *Æquilibrium* is broken, and one of theſe Powers prevails over the other, the Effects will be very great and ſenſible, as we ſhall ſee farther on.

Now from hence it is evident, that the intercoſtal Muſcles and Diaphragm cannot act ſo as to raiſe the Ribs and enlarge the Cavity of the Thorax, unleſs the external Air be at the ſame Inſtant of Time admitted into the Lungs, to fill up the internal enlarg'd Cavity of the Breaſt, and thereby ſupport it againſt the Weight and Preſſure of the external Air. For ſhould we ſuppoſe the Ribs to be raiſed, and the Cavity of the Thorax enlarg'd, without the Admiſſion of the external Air; the external Surface of the Thorax muſt, as has been ſhewn in that Caſe, ſuſtain a Weight or Preſſure equal to 4860 Pound: A Weight againſt which the elevated Ribs could not poſſibly be ſupported by the natural Power of the Muſcles, without the inſtantaneous Immiſſion of the Air into the Lungs, by which the internal Cavity being fill'd, the elevated

Ribs will be ſupported and kept *in Æquilibrio*, againſt the contrary Weight and Preſſure of the external Atmoſphere.

And for the ſame Reaſon that the Thorax cannot poſſibly be rais'd and ſupported without Inſpiration, or the Immiſſion of the external Air into the Lungs, it muſt neceſſarily ſubſide, upon the Emiſſion of the Air, in Expiration; ſince otherwiſe it muſt continue elevated and ſuſtain'd, in oppoſition to a Weight againſt which it could not poſſibly be rais'd at firſt: which is equally impoſſible.

Voluntary Reſpiration therefore is thus perform'd: When the intercoſtal Muſcles and Diaphragm are ſtrongly impreſs'd and contracted by the Power of the Will, the external Air ruſhes in to fill up the internal Cavity, and ſupport the riſing Breaſt againſt the Weight of the Atmoſphere. On the other hand, when the muſcular Coats and Fibres of the Lobes and Veſicles of the Lungs are forcibly contracted by the ſame Action of the Will, and the contain'd Air driven out, the Weight of the Atmoſphere muſt again take place, and neceſſitate the Thorax to ſubſide, to avoid a Weight or Preſſure too powerful for the contractive Force of the Muſcles, which had before rais'd and ſuſpended the Thorax. From whence 'tis plain, that as the Air admitted into the Lungs is the means of ſuſtaining the elevated Breaſt, againſt the otherwiſe inſupportable Weight of the Atmoſphere; ſo the ſame Weight and Preſſure

of

of the external Air, neceſſitates the ſubſiding of the Thorax, upon the Contraction and Compreſſion of the Lungs. And after this manner the Lungs, by the Intervention and conjunct Action of the Atmoſphere, is the antagoniſtick Power to the intercoſtal Muſcles and Diaphragm.

SCHOLIUM I.

SINCE the Blood-Veſſels, when the Muſcles contract, are ſtrongly compreſs'd, and the Blood forc'd out of them, as has been ſhewn; a Difficulty may here ariſe, how it ſhould come about, that upon any ſuch Compreſſion the Blood is not driven equally both ways, or in two contrary Directions at the ſame time. Now to prevent this Effect, which muſt be inconſiſtent with animal Life, and ſoon put a ſtop to the Circulation of the Blood, the Author of Nature has in the firſt place provided the Veins, at certain ſmall intervals, with Valves, which open towards the right Ventricle of the Heart, to make way for the Paſſage of the Blood in its natural Courſe; but ſhut and cloſe the contrary way, ſo as to prevent any reflux of the Blood back again upon the Arterys: and at the ſame time, the Reflux of the Blood from the Arterys, is prevented by the ſtrong Valves which ſhut up the Orifice of the *Aorta*, and which opening to let the Blood paſs from the left Ventricle, do preſently cloſe again to hinder its return from the Arterys upon

the Heart; by which means, when the Blood Veſſels in a Muſcle are compreſs'd and conſtring'd by the contracting elaſtick nervous *Fibrillæ*, it muſt neceſſarily be driven forward in its natural Direction; that being the only way in which any impreſs'd Force can determine it.

But ſecondly, it muſt be obſerved farther, that all muſcular Motion is propagated ſucceſſively, according to the natural Direction of the Blood in the Courſe of its Circulation. For ſince the Blood-Veſſels are ſtretch'd and diſtended by the Influx of the Blood from the Heart; if theſe Veſſels are ſuppoſed to be divided into innumerable ſmall tranſverſe contiguous Sections, 'tis evident that all the Sections throout the whole Length of a Veſſel, will not be ſtretch'd and diſtended inſtantaneouſly and preciſely at the ſame time; but ſucceſſively, in conſequence of the ſucceſſive Motion and Propagation of the Blood. And ſince the muſcular elaſtick Fibres contract in conſequence of, and in proportion to the ſtretching diſtending Force of the Blood, 'tis plain that the Contraction muſt firſt begin where the Diſtenſion was firſt made; and be propagated ſucceſſively after the ſame manner, and in the ſame Direction.

This ſucceſſive Propagation of muſcular Motion is very viſible in the Heart, whoſe Auricles begin to contract firſt, and then the Ventricles at a very ſmall but ſenſible interval, as the Blood is propell'd forward. And this

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ſucceſſive propagation of Motion, will be more diſtinct and ſenſible as the Heart grows weak, and the Motion ſlow and languid: for then it may be plainly perceiv'd, that the Motion begins at the right Auricle, from whence it proceeds to the left, and from thence to the Ventricles; and the right Auricle will continue moving, or dilating and contracting for ſome time after the left Auricle and Ventricles are at perfect Reſt.

But this ſucceſſive propagation of muſcular Motion, is moſt viſible and remarkable in the Inteſtines; where the alternate Dilatation and Contraction beginning at the Stomach, is continu'd by ſucceſſive Undulations thro the whole Length of the Guts; by which means, their Contents are ſtill preſs'd and ſqueez'd forward towards the *Anus*: but upon any violent and preternatural Inverſion of this Motion, the Contents of the Inteſtines are all brought upward, and diſcharg'd at the Mouth. And after the ſame manner, the Blood muſt be driven back upon the Heart, and all the Valves and Flood-gates of the Machine broke to pieces, were it not for this natural Direction and ſucceſſive Propagation of muſcular Motion; which miſchief is hereby effectually prevented.

SCHOLIUM II.

Another Queſtion may be rais'd upon this Subject, of which it may not be amiſs to take ſome notice here; and that is, How

an elaſtick Fluid, ſuch as the Air, ſhould be any ways neceſſary to the Ends and Purpoſes of Breathing. For 'tis manifeſt, that any other Fluid, tho not at all elaſtick, in which our Bodys might have been immers'd, muſt upon the Elevation of the Thorax have ruſh'd into the bronchial *Veſiculæ*, ſo as to diſtend and fill them up: and upon the Contraction of theſe Veſicles, the Blood-Veſſels of the Lungs muſt have been conſtring'd and compreſs'd, and the Blood driven forward after the ſame manner: and conſequently, ſome other important uſe of the Air in Breathing muſt be allow'd, beſides this alternate Dilatation and Compreſſion of the Blood-Veſſels, in the muſcular Action of the Lungs.

Now 'tis certain from *Prop.* 35,36. *Part* I. that the Air join'd with elementary Fire, is abſolutely neceſſary to keep up the Fluidity and natural Heat of the Blood; without which, it muſt immediately cool, condenſe, and become a fix'd ſolid Maſs: And 'tis extremely probable, at leaſt, that as the Air is thus abſolutely neceſſary to theſe Purpoſes, ſo there is a neceſſity likewiſe of a continual ſupply of cool freſh Air, to be diffus'd thro the whole Maſs, while the Air before contain'd in it, being over-heated and rarefy'd, is perpetually flying off thro the Cutaneous Glands in Perſpiration, and perhaps thro all the other Excretory Ducts and Out-lets of the Body.

But there ſeems no way ſo proper and convenient for ſupplying the Blood with freſh Air, as from the Lungs, thro which the whole Maſs ſucceſſively paſſes. From theſe bronchial *Veſiculæ*, the finer and more attenuated Parts of this elaſtick Fluid, by means of certain very minute tranſverſe *Tubuli*, may be drawn off, convey'd into the Blood-Veſſels, and mix'd with the Blood; while the groſſer Element is driven out by the Contraction of the Veſicles, and the Blood ſqueez'd and propell'd forward by the muſcular Action of the Lungs, as before explain'd.

A due Quantity and Proportion of this ætherial Fluid, is neceſſary to keep up the natural Heat and Fluxility of the ſanguinary Maſs: but where it too much abounds, as being retain'd and pent up by the too great Viſcidity of the Maſs, the heated rarefy'd Air not paſſing off as the freſh Air is deriv'd; the Blood, in this Caſe, muſt become turgid and flatulent, run into preternatural Ferments, and over-ſtretch and diſtend the containing Veſſels, eſpecially in the Glands and Lymphaticks; the Conſequences of which are very obvious. 'Tis very plain that the natural and due State of the Blood and animal Fluids, muſt depend very much upon the juſt Ballance and Æquipoiſe of the external and internal Air: While this *Æquilibrium* is duly maintain'd, the animal Fluids are *cæteris paribus*, in a natural and good State; but this Æquipoiſe being broken, either by increa-

increaſing the Viſcidity of the Blood, and a too great Quantity of Air detain'd in it, or by leſſening the Weight and Preſſure of the Atmoſphere, the Effects muſt be very ſenſible and conſiderable, eſpecially upon Valetudinarians; and above all, ſuch as are ſubject to the peculiar Diſeaſes and Diſorders of the Head and Stomach: For in ſuch, the Cauſe here aſſign'd muſt be attended with preternatural Heats, aſthmatick Breathings, hyſterical Suffocations, Lethargys, Vertigo's, Apoplexys, Epilepſys, and all the Appearances and Symptoms of Over-fullneſs, Rarefaction, and Diſtenſion.

Now as theſe Diſeaſes are ſome of the moſt grievous that can befall us, in which the ſtretching diſtending Force of the Blood overpowers the contractive reſtitutive Force of the muſcular nervous *Fibrillæ*, 'tis plain from hence how much it concerns the Phyſician, in all ſuch Caſes, to reduce the Blood and animal Fluids to a due ſtate of Fluxility, and to relieve the over-ſtrain'd Veſſels by proper and timely Evacuations, that the motive Fibres may be at liberty to contract and recover their elaſtick Tone.

PROPOSITION VII.

TO explain the Flux and Reflux of the Vital Fluid, or the occaſional Elevation and Depreſſion of the Blood.

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'Tis well known, that the animal Conſtitution is ſubject to very conſiderable Alterations and Changes, with reſpect to the diffus'd Heat and Efflatus of the Blood, and the Life, Vigour, and Briskneſs of Thought and Motion. A Man ſometimes finds himſelf ſtrong, active and lively; his Pulſe is raiſed, his natural Heat diffuſed, and he is every way diſpos'd for Thought and Motion: At another time the ſame Perſon is liſtleſs, languid and dull; his Pulſe weakens, his natural Heat retires, and he is altogether unfit for any Action of the Body or Mind. This Reciprocation is commonly call'd the riſing and ſinking of the Spirits: and as this Viciſſitude and interchangeable State of the Conſtitution falls under every one's Obſervation and Experience, ſo every body knows by what means the Spirits are depreſs'd and ſunk, and what the uſual Methods are of raiſing them: But 'tis my buſineſs here only to explain the Mechaniſm of thoſe different Phænomena or Appearances, and to ſhew from what Cauſes and by what Means they are induced and brought about.

From what has been ſhewn, *Prop.* 4. it muſt, I preſume, be ſufficiently evident, that all muſcular Motion is perform'd by the intrinſick elaſtick Force of the nervous *Fibrillæ*, contracting and reſtoring themſelves againſt the ſtretching diſtending Force or Impetus of the refluent Blood: and conſequently,

ly, as long as these two Counter-Weights or Powers are kept *in Æquilibrio*, and their natural and due Ballance maintain'd, the alternate Dilatation and Contraction of the muscular Organs will be regular, and the animal Constitution sound and healthy. But where these motive Powers rise too high or sink too low, or where the *Æquilibrium* is broken, by one of the Counter-forces prevailing over the other, the Motion must become irregular and preternatural, that is, morbifick or diseased.

If therefore the Dilatation of any muscular Organ be strengthned and increased, by the increased *Momentum* of the refluent Blood, the elastick motive *Fibrillæ* from the *Stimulus* of their stretch or bent, will contract themselves more forcibly to a certain Degree, proportional to the stretching distending Impetus of the Blood, by which the *Æquilibrium* of the two Counter-forces will be still retain'd; but the Action of the Muscle, or its alternate Dilatation and Contraction, will be quicker, stronger, and more intense. And this Augmentation of muscular Motion, may be either in a just and due Proportion, so as to increase and perfect the animal Strength, Activity and Vigour, or in a preternatural and immoderate Degree, so as to become morbifick, and very pernicious to the Animal Constitution.

But where the Force and Impetus of the Blood ſhall be too ſtrong for the contractive Power of the nervous elaſtick Fibres, the *Æquilibrium* will be broken, and the Action of the Muſcle muſt become weak and languid, by a Diminution of the contractive Force, now overpower'd by the contrary ſtretching diſtending Force of the Blood; while on the other hand, where any ſuch muſcular Organ is depriv'd of its due Quantity and Proportion of Blood, the nervous elaſtick Filaments contracting by their own innate Energy, the muſcular Action muſt weaken and languiſh, from the Diminution of the ſtretching diſtending Force of the Blood, now overpower'd by the compreſſive Force of the contracting Nerves upon the Blood-Veſſels. Now after what manner muſcular Motion, and all animal Force, Activity and Vigour, may be rais'd or depreſs'd by the Afflux and Reflux of the Blood to and from the Head and ſuperior Parts, will appear from the following Phænomena, and the plain and obvious account of them.

PHÆNOMENON I.

All Opiates, volatile Salts, inflammatory Spirits, heating fermented Liquors, volatile pungent Aromaticks, Camphire, Saffron, and in general all Subſtances which conſiſt of very ſubtile attenuated Parts, and ſuch as are diſpos'd with a ſmall degree of Heat, to rarefy and run into a Fermentation and *Flatus*; produce

produce their Effects immediately upon the Stomach, by raising the Pulse, diffusing the Heat of the Blood, and increasing the Force and Vigour of animal Motion; and this before any Digestion, Chylification, or Conveyance of those Substances into the Blood, can be suppos'd or imagin'd.

EVERY body knows the immediate Effects of a Dram, or a Draught of any warming spirituous Liquor, in raising the Pulse, diffusing the natural Heat, and invigorating the animal Functions almost instantaneously, and as soon as ever they are taken into the Stomach. And that Opiates, volatile Salts, and Alexipharmicks, have the same immediate and, in a manner, instantaneous Effects, is plain from Experience, while the Substances themselves are still retain'd in the Stomach, and may be thrown out of it by vomiting, for a considerable time after their being taken in. From whence 'tis plain, that the immediate Action of those Substances is upon the Stomach.

PHÆNOMENON II.

STRONG mineral Acids, such as the Spirit and Oil of Sulphur and Vitriol, fix'd Salts, raw acid Fruits, low thin unfermented Liquors, and in general every thing of a very cooling, constringing and condensing Nature, produce their Effects likewise immediately upon the Stomach, before Digestion or Chylification: in which Case, the present sensible Effects

Effects of cooling, refrigerating, lowering the Pulse, recalling the natural Heat, *&c.* are directly contrary to those last-mention'd under the foregoing Head.

Now in order to account for these different Phænomena, it may be observed, that the Stomach is a large concave Viscus or Bowel, seated in the Abdomen below the Diaphragm, which is capable of being blown up and rarefy'd to a considerable Degree, by the Heat and Rarefaction of any thing received into it; or, on the other hand, of being contracted, so as to bring the opposite Points of its muscular Coats into a Contact, by any thing admitted into it of a cold, condensing and stimulating Nature.

'Tis likewise matter of Fact, that the descending Trunk of the *Aorta* passes down behind the Stomach, and between that and the Spine, or back-part of the Ribs: from whence 'tis evident, that when the Stomach upon any occasion is inflated and distended, the descending Trunk of the *Aorta* must be compress'd or constring'd, between the Stomach and the Spine or *Costæ*; by which means, the Orifice or transverse Section of this Artery in its descending Branch, must be lessen'd, which must impede or resist the Descent of the Blood from the Heart, and oblige it to ascend in a greater Quantity and Proportion to the Head and superior Parts, where there is no such Resistance. By this means, the Head and all the Parts which are supply'd from

from the ascending Trunk of the *Aorta*, will be more stretch'd and distended with Blood, than the inferior Parts which are supply'd from the descending Trunk.

BESIDES this Ascent or Afflux of the Blood to the Head, occasion'd by the Distension and Inflation of the Stomach, and the consequent Compressure of the descending Trunk of the *Aorta*, there is another considerable Cause of the same Elevation, Tide, or Afflux of the Blood, from the same Inflation of the Stomach. 'Tis evident from the foregoing account of muscular Motion, that when the muscular Coats of the Stomach are thus stretch'd, inflated, and distended, the Blood-Vessels which enter into the Constitution of those Muscles, must at the same time be stretch'd, dilated, and remain full and turgid with Blood; which Blood cannot be driven forward in the Course of its Circulation with its natural and due Velocity, but by the Contraction of the muscular Coats of the Stomach, and the compressive Force of their nervous elastick Fibres upon the Blood-Vessels: and therefore, so great a Quantity of Blood as must be retain'd and retarded in these Blood-Vessels, during this Distension and Inflation of the Stomach, must prove an Obstacle or Resistance to the Descent of the Blood from the Heart, and oblige the vital Tide to move upwards in the ascending Trunk of the *Aorta*, with an augmented Force and Impetus towards the Head, as before.

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As this Diſtenſion and Inflation of the Stomach, from the Rarefaction, Heat, and Fermentation of its Contents, muſt accelerate the Velocity of the Blood in the aſcending, and retard in the deſcending Trunk of the *Aorta*; ſo 'tis manifeſt that when this *Flatus* and Diſtenſion, and the conſequent Reſiſtance to the Deſcent of the Blood are taken off, the quite contrary Effects will follow: for the Blood now meeting with leſs Reſiſtance downward, ſuddenly changes its Courſe, and its Velocity and *Momentum* muſt be augmented in a contrary Direction, by this Alternation and occaſional Afflux and Reflux of the Blood; the Pulſe is accordingly ſtrengthen'd or weaken'd, the natural Heat raiſed and diffuſed, or recall'd and concentred; and the animal Functions in general are either quicken'd and invigorated, or infeebled and depreſs'd.

SCHOLIUM.

From this Principle, the Nature of Sleep, the Effects of Opiates, ſpirituous Liquors and volatile Salts; and the Origination and Cure of all ſoporiferous narcotick Diſeaſes, are eaſily underſtood and explain'd: of which I ſhall here give ſome general Caſes, including and comprehending all the reſt.

1. When the Heat and Rarefaction in the Stomach, and its conſequent Diſtenſion, are moderate, ſuch as may be occaſion'd by the Heat of the Fire after Cold, an ordinary

Meal, a Glaſs or two of Wine, a good warm Dram, *&c.* this turns the Blood upward with an accelerated Velocity, but in an eaſy, equable, and uniform Stream; and hereby the Pulſe ſtrengthens, and animal Life and Motion are quicken'd and invigorated, the vital Fluid glows thro the Veins, the Blood-Veſſels in the Brain are agreeably and gently diſtended, and the Nerves in their Origin at the Brain are put into a ſoft, eaſy, undulating Motion; and this, by taking off any uneaſy or painful *Stimulus*, which might have been occaſion'd by Watching, Labour, Paſſions, or too great Evacuations, ſtrengthens and aſſiſts the Operations of Nature at the Spring-Head, and diffuſes a warm invigorating Pleaſure thro the whole Frame.

2. If this Afflux of the Blood or vital Tide to the Head be increaſed ſomewhat farther, ſo as pretty ſtrongly to dilate and diſtend the Blood-Veſſels in the Brain, and preſs upon thoſe Nerves which are the Organs of Senſation; the Action of theſe Organs and Inſtruments of Senſation will be hereby weaken'd, interrupted, or quite ſuſpended; according to the degree and meaſure of their Compreſſion, by the turgid diſtended Blood-Veſſels: and this will induce a Heavineſs, Drouſineſs or Sleep.

3. When this Drouſineſs or Sleep becomes preternatural, from the aforeſaid Afflux of the Blood, the Diſtenſion of the Blood-Veſſels in the Brain, and the conſequent

Compreſſion of the Organs of Senſation being too great and too long continued; the Conſequence will be what we call a Lethargy.

4. If this Afflux of the Blood be not ſo great as to produce a Lethargy, but yet is longer continu'd in a more moderate Degree; any ſuch conſtant and too great Afflux of a too great Quantity of Blood to the Head, will ſeparate a greater Quantity of Lymph or Serum than ordinary, in the choroidal, pineal, and pituitary Glands, whoſe Lymphaticks or Aqueducts being hereby ſtretch'd, diſtended, and at laſt broken, produces a Dropſy of the Brain, which is the moſt general and genuine Cauſe of a Palſy.

5. If the Blood by this means be thrown with a ſtrong, ſudden, and violent Torrent to the Head, ſo as to break the Blood-Veſſels, or ſtretch and diſtend them beyond the reſtitutive contractive Power of the Nerves, the Conſequence is an Apoplexy.

6. If this Cauſe be ſomewhat remitted, and does not prove directly mortal and deſtructive to the animal Nature, it often terminates in a confirm'd habitual Epilepſy.

7. This Afflux or Tide of the Blood being ſtill brought a little lower, ſo as not to take away all Senſe and Motion, but only to bear up the Diaphragm and Lungs, and hinder the Immiſſion of the Air in a due Quantity; eſpecially when attended with the like Inflation and Diſtenſion of the Womb in Women, will produce all the Species and Symptoms

of ſtrangulating convulſive Fits and hyſterical Suffocations.

This general morbifick Conſtitution, proceeding from the various Modifications of the vital Tide, or Afflux of the Blood to the Head, will be much ſtrengthen'd, and the Diſpoſition towards it increaſed, by any organical Diſorder in the Brain; either from the wrong Conformation of its Veſſels, or from ſome large, hard, and indiſſoluble Tumor of any of its forementiond Glands.

The ſame morbifick Conſtitution is likewiſe generated, confirm'd, and ſtrengthen'd by the Weakneſs, Relaxation and Flaccidity of the muſcular Coats of the Stomach, and the foulneſs of its Glands, ſtuff'd with a viſcid tenacious Lymph or Slime. For in the firſt Place, the Nerves and Blood-Veſſels in the Brain being compreſs'd and too cloſely pent up, any ſmall Quantity of Blood more than uſual paſſing upward, muſt have the greater and more ſenſible Effects, for want of ſufficient Room and Capacity of Diſtenſion in the compreſs'd ſtreighten'd Blood-Veſſels: and from the weakneſs of the muſcular Coats of the Stomach, any Heat, Rarefaction, and Flatus of its Contents muſt the more forcibly diſtend and blow it up, while the elaſtick reſtitutive Force of its muſcular Springs is not ſufficient to reſiſt the Rarefaction of the included over-heated and expanſive Air: and the Glands being ſtuff'd and loaded with a viſcid Serum or Slime, retaining a great Quan-

tity of Air, and mixing with the Meat and Drinks in the Stomach, will very much contribute to increaſe and ſtrengthen the aforeſaid Rarefaction, Flatus and Diſtenſion.

FROM this general account of Cauſes, the chief Intentions in the Cure are plainly theſe.

1. To make a ſpeedy and effectual Derivation and Revulſion of the Blood and Humours from the Head.

2. To cleanſe and ſcour the Glands and ſecretory Ducts of the Stomach, by proper Emeticks repeated as occaſion ſerves.

3. To keep up an eaſy, free and open Secretion by Stool.

4. To cleanſe and open the ſmall Blood-Veſſels, Glands, and Lymphaticks of the Brain from any Dregs and Recrements, to make way for the free Circulation of the Blood and Lymph: and this will be beſt done by mercurial Deobſtruents; of which the Cinnabar of Antimony, Æthiops Mineral, and the Antihectick of *Poterius* are principally to be regarded, join'd eſpecially with black Hellebore.

5. To ſtrengthen the muſcular Force and Action of the Stomach by proper Corroboratives, of which the Peruvian Bark is the chief, and ſtands beyond all Competition againſt every thing elſe, in confirming a good Digeſtion, and preventing the Returns of any of theſe capital periodical Diſeaſes. But the more diſtinct Conſideration of what may be farther neceſſary to anſwer the chief Intentions of Cure, in this and the ſeveral other

principal morbifick Conſtitutions, I ſhall refer to the third and laſt Part, where it will fall more directly and properly under my intended Deſign.

PROPOSITION VIII.

TO explain the Nature and Uſe of animal Secretion.

THE Arterys in their laſt evaneſcent Branches, or ſmall Diviſions, before they are incurvated into their returning Veins, ſend out innumerable very minute hairy *Tubuli*, thro which certain Portions of the Serum are drawn off from the Blood, while the Remainder paſſes on thro the Extremitys of the Arterys, and returns by the Veins: and theſe exceeding fine Pipes or *Tubuli*, by which the Serum is partly drawn off from the Blood, before it paſſes the ſmall capillary Arterys, are call'd the glandular Strainers, or ſecretory Ducts.

THE laſt Branches and ſmall Diviſions of any Artery, together with their glandular ſecretory Ducts, their correſpondent Twinings, and Ramifications of the Nerves and their returning Veins, being convoluted and wound up together, and included within a common Tunicle or Tegument, conſtitute a ſmall roundiſh hard and fleſhy Subſtance, which is call'd a Gland; and for Diſtinction ſake, a conglobate or ſimple Gland.

ANY

ANY Number or Congeries of these conglobate or simple Glands, being fasten'd together by small transverse Fibres, and included again within a common Coat or containing Membrane, is call'd a conglomerate or compound Gland.

THESE secretory Ducts or glandular Strainers, which spring immediately from the last Branches and Divisions of the Arterys, uniting in the Glands, are sent out in larger Pipes or Canals, for the Propagation and Distribution of their secreted Liquors, in order to answer the several Ends and Purposes of these glandular Secretions in the Animal Oeconomy; and of which Glands, with respect to their general uses, there are two very different and remarkable sorts: for either they convey their secreted Liquors thro their proper secretory Ducts to be cast out of the Body, to free the Blood from the superfluity of Serum, which is still growing and accumulating from what we eat and drink; or else they deposite their Secretion in proper Receptacles, and distribute them thro certain Pipes to be empty'd again into the Blood, under the common Name of *Lymph:* by which means, there is made a continual Drain of Serum from the Blood in the Arterys, which being distributed or circulated thro a certain Course in the Lymphaticks, is return'd again upon the same Blood in the Veins. The first of these I call by way of Distinction, the *expurgatory*, and the other the *circulatory* or *lymphatick*

GLANDS. Both these sorts of Glands are in number indefinite, and dispers'd over all the fleshy Parts of the Body: but the expurgatory Glands are for the most part of the compound or conglomerate Kind; whereas the circulatory, or those Glands which serve to secrete the circulating Lymph, are generally simple or conglobate: of these lymphatick Glands, an Infinity are to be found in the Intestines, the Mesentery, the Omentum, the Spleen, the Liver, and all the Parts of the Abdomen, which convey their secreted Lymph into the common Receptacle of the Chyle, and from thence together with the Chyle, it is empty'd into the Blood by the Axillary Veins; and indeed the Lacteals, which receive the Chyle from the Stomach and Intestines, and convey it to the Blood, are truly and properly Lymphaticks, and perpetually flow with Lymph derived from these Glands, and which is incessantly draining off from the Arterys: by which means, all the chyliferous Ducts from the Intestines to the Subclavian Veins, are continually fill'd with this circulating Lymph, whether they have any Chyle in them or not. And besides these lymphatick Glands arising from the several Parts contain'd in the Abdomen, which convey their Lymph to the Blood thro the common Receptacle of the Chyle, there are innumerable others of the same kind in almost every other Part of the Body, which drain the Lymph from the Arterys, and communi-

cate

cate with the Veins by nearer and shorter Passages, without distributing their Serum to the common Receptacle and chyliferous Ducts; many of which have been observ'd and describ'd by Anatomists, and numberless others are doubtless too small and fine for any Observation or Description.

Now the Intentions of Nature in the general Structure and Constitution of the Glands, are manifestly these two.

1. The Blood being discharged out of the large Vessels, and thrown into the numerous small Branches and Divisions of the evanescent Arterys, has its Velocity and Impetus exceedingly abated, by *Prop.* 3. of this Part. And the Velocity and Impetus of the Blood abating, the Heat and Rarefaction of the expansive Elements must be diminish'd, and the corpuscular Attraction of the Blood-Globules increas'd in the same Proportion, by *Prop.* 37. *Part* I. from whence, by *Prop.* 38. there will be a more perfect Separation of the globular Part of the Blood from the Serum, and way made for the Serum to disengage it self, and shed off from the *Crassamentum*: and therefore, all the fine glandular secretory Ducts are sent out from the Arterys in these their ultimate Branchings and Divisions, where the corpuscular Attraction being greatest, and the heating rarefying Force of the expansive Elements least, such a Separation of the Serum from the globular Part can only be made; whereas, had these glandular secre-

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tory Ducts been ſent out from the larger Veſſels, where the Velocity and expanſive Force of the Blood is very great, and where conſequently the Serum is intimately mix'd with, and ſtrongly retain'd by the *Craſſamentum*, nothing could have been ſeparated or ſecreted but Blood, or the mix'd Maſs without Alteration.

By means of theſe minute *Tubuli*, ſuch as are the evaneſcent capillary Arterys, and the ſecretory Ducts of the Glands, a very ſlow and imperfect Circulation might have been obtain'd without any thing of muſcular Motion, as is the Caſe in Trees and Vegetables of all ſorts; for in theſe the Sap riſes from the Root, thro an infinity of exceeding minute Pipes or ſmall Tubes, by the corpuſcular Attraction of the minute Parts; as explain'd *Prop.* 35. *Part* I.

But a quicker and ſtronger Circulation was abſolutely neceſſary to Animal Life, and in order to keep up the natural Heat, Efflatus, and due Fluidity of ſuch an oily, mucilaginous, and concreſcible Liquor as the Blood. And therefore,

2. The infinitely wiſe Author and Former of Nature has contriv'd and provided a proper Expedient to this Purpoſe, in the Structure and Conſtitution of the Glands; which are manifeſtly conſtructed and adjuſted to obtain the greateſt poſſible Benefit and Advantage of muſcular Force and Action.

'Tis

'Tis commonly known, that the Arterys in all their minute Diviſions and Subdiviſions, are not only provided with muſcular Coats, but likewiſe attended with their correſpondent ſmall Twinings and Ramifications of the Nerves. Now had the ultimate minute Branches of the Arterys been ſuffer'd to run out into ſingle ſmall hairy Twigs and Sproutings, the muſcular Force in theſe ſingle ſmall *Tubuli* muſt have been very weak; and conſequently the Circulation thro them exceeding ſlow, like that of the Sap in Vegetables; which could not have anſwer'd the neceſſary Ends of Animal Life and Motion: to prevent which, theſe ultimate minute Branches of the Blood-Veſſels, with their correſpondent Twinings and elaſtick Filaments of the Nerves, and ſmall ſecretory Ducts or glandular Strainers, are cloſely compacted, wound up together, and included within their common muſcular Coats. From which Contrivance, the Glands thus form'd and conſtructed, muſt acquire and exert a very conſiderable muſcular Force: For while the numerous nervous elaſtick *Fibrillæ*, the muſcular Coats of the ſmall Arterys, and the common muſcular Teguments of the Glands themſelves act conjunctly with their united Forces, and within a ſmall Compaſs; the Blood muſt be hereby ſqueez'd out of theſe evaneſcent Arterys into the Veins, and the Lymph or Serum will at the ſame time be compreſs'd and ſqueez'd out of the numberleſs ſmall ſecretory Ducts which

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ſpring from the Arterys, and driven forward into the larger Lymphaticks and Aqueducts which paſs out of thoſe Glands, and propagate or diſtribute their proper Liquors to their ſeveral and reſpective Receptacles, Emunctorys, and excretory Ducts, to ſerve the various Ends and Purpoſes of Animal Life and Motion.

THIS muſcular Action of the Glands is evident, not only from their Structure, with reſpect to the Diſpoſition of the Nerves and Blood-Veſſels, which is the ſame here as in the Heart, the Diaphragm, and all other Muſcles of mere natural Motion; but is likewiſe obvious enough to Sight, in all the larger and more compound Glands; but eſpecially in the Stomach and Inteſtines, which conſtitute a true and proper Gland, the largeſt and moſt remarkable in the whole Body; of which large and complicated Gland, the *Lacteals* are the ſecretory Ducts, and the *Anus* the common Emunctory or excretory Duct, thro which the groſſer, ſuperfluous, and uſeleſs Part of what is digeſted in the Stomach is thrown out. And tho this firſt, principal, and moſt noble Gland, differs in ſome Circumſtances from the other ſimple and compound Glands already deſcribed, yet with reſpect to its main and eſſential Organization, Structure and Uſe, as a Gland contrived and deſign'd for Secretion, it is the very ſame. And,

THO

THO theſe Glands have taken their general Name from their Figure, and moſt obvious ſenſible Qualitys, as ſmall, hard, criſp, ſpongy, whitiſh, and roundiſh Bodys or Kernels, ſuch as the conglobate Glands commonly are, of which the conglomerate are compoſed: yet if one might be allow'd to denominate them from their real Structure and principal Uſe, they might very properly be call'd the Secretory Muſcles; ſince their Action is plainly muſcular, and abſolutely neceſſary to ſqueeze and drive forward the Blood and animal Secretions thro the capillary Arterys, and fine glandular ſecretory Ducts reſpectively; as much as the Motion of the Heart it ſelf, which is allow'd to be a Muſcle, or as any of thoſe other Muſcles commonly ſo reckon'd, which ſerve to move the Parts, according to their different Directions.

AND indeed, nothing could have hinder'd theſe Glands from being rank'd under this Claſs, as a particular ſort of Muſcles, but that their Action in their alternate Dilatation and Compreſſion, is leſs ſenſible, and their real internal Structure and Conſtitution have not been ſo well underſtood or adverted to.

HAVING premiſed thus much concerning the general Structure, Conformation, and Uſe of the Glands, we may now the more eaſily and intelligibly explain the Reaſon of thoſe different Secretions, and their more particular and appropriated Uſes.

'TIS

'Tis plain in Fact, that the expurgatory Glands especially secrete Liquors of different sorts, with respect to their different Degrees of Fluidity and Viscidity, Tenuity and Crassitude, and as they are differently stock'd and repleniſh'd with Oil, Sulphurs, volatile and fix'd Salts, and various sorts of Earths, as Chalk, Sand, Clay, Gravel, *&c.*

And because all Fluids press equally *undiquaque*, 'tis likewise certain, that all the Vessels and organical Parts thro which the Fluids are continually passing, must be Cylindrical or Conical; that is, their transverse Sections must be Circular: this being the necessary Consequence of the equal uniform Pressure of their circulating Fluids, which press, dilate and distend them alike in all Directions: And consequently all the different Secretions, as just now mention'd, must depend on these three things.

1. On the different Diameters or Orifices of the secretory Ducts, or glandular straining *Tubuli*.

2. The different Velocity of the Blood at the several secretory Ducts, as the Arterys are more or less complicated and divided before the Secretion is made. And,

3. On the different Serosity of the Blood when brought to the secreting Gland, as it has been more or less drain'd of its Serum before its arrival.

As to the first, 'tis plain that all the secretory Ducts will admit any Particles that are small

ſmall enough to paſs thro them; that is, any Particles whoſe Diameters are not larger than the Diameters of thoſe ſecretory Ducts themſelves: and conſequently the pure Serum, Lymph, or fluid Part of the Blood may be ſecreted any where, as being capable of ſuch Attenuation and Diviſion of its Parts, as to enter the ſmalleſt and moſt minute Paſſages that can be conceiv'd or imagin'd; while all the ſolid Corpuſcles and larger Particles endu'd with a ſtronger Coheſion, whoſe Parts cannot be ſo intimately ſeparated, divided and attenuated, muſt be kept back, and deny'd an entrance thro thoſe finer and moſt minute *Tubuli*. But as the Diameters of theſe glandular ſecretory Ducts are enlarg'd, they will be capable of admitting Corpuſcles of a cloſer and ſtronger Coheſion, and that in a greater or leſs Proportion, as the Orifices of the ſecreting Tubes are enlarg'd: which different proportional Mixture of Salts, Sulphurs, Earths, *&c.* with the Serum, will conſtitute ſecreted Liquors of different Kinds, or different ſenſible Qualitys; according to the different Nature and Quantity of ſuch cohering Corpuſcles, with which the ſeparated Serum is thus blended and repleniſh'd.

THE Secretions will likewiſe differ, on the Account of the different Velocity of the Blood at the Orifices of the ſecretory Ducts: For ſince the Velocity and Impetus of the Blood is the Force by which all the muſcular Organs are ſtretch'd and dilated; and ſince the

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nervous elaſtick *Fibrillæ*, within their natural and due Bounds of Tenſion, contract and reſtore themſelves in proportion to the Force by which they are ſtretch'd and dilated, 'tis plain that the muſcular Force and Action of a Gland, will be proportional to this Velocity and *Momentum* of the Blood; and the Quantity ſecreted in a given time, or the Velocity of the Secretion muſt be in the ſame Proportion: but the quicker any Secretion is made, or the faſter the Serum is drawn off from the Blood, the thinner and more limpid or fluxile it will always be; whereas, when it drains off but ſlowly, and continues long in the Glands and ſecretory Ducts, it contracts a greater Viſcidity, and becomes more tenacious and mucilaginous: This is evident in all the Secretions which are more thin and fluid in proportion to the Quickneſs of their Drain, or the Quantity diſcharg'd in a given time. But where any Matter is forced off which has continu'd long in the Glands, or ſtagnated in the Lymphaticks and Aqueducts, it is always thick, viſcid and ſlimy, as having been turn'd into a ſort of Gelly or Lentor, by the natural Heat under a ſmall Degree of Motion: And from hence it muſt follow, that thoſe Secretions which are drawn off from the moſt Glands, or the moſt complicated Arterys, and after the greateſt Number of Diviſions, are the moſt viſcid; and thoſe which are drawn off from the leaſt complicated Arterys, after the feweſt Diviſions, are,

are, *cæteris paribus*, the thinneſt and moſt fluid.

But laſtly, the Secretions differ alſo on account of the greater or leſs Seroſity of the Blood, when brought to the ſecretory Ducts of any particular Gland, as having been more or leſs drain'd of its Serum before in other Glands. Of this we have a very famous and pregnant Inſtance, in the wonderful Apparatus and Conduct of Nature for the Secretion of the Bile in the Liver; and this being not only a curious but a uſeful Speculation, in which others who have gone before me have not been very ſucceſsful, I ſhall here conſider it the more diſtinctly.

'Tis well known, that the Method which Nature has taken for ſupplying the Liver with Blood, is very extraordinary; for this famous Organ, contrary to all others, receives the Blood from which its proper Secretion is made, not from the Arterys, but from the Veins.

Here therefore, the Blood which had been communicated by the Arterys, and diſpers'd thro the Inteſtines, Meſentery, Caul, Spleen, Pancreas, Stomach and Gall-bladder, returns by the correſpondent Veins, which uniting in one large Trunk call'd the *Vena Porta*, the Blood is hereby after this wide and roundabout Courſe brought to the Liver, and diffus'd thro its whole Subſtance by the numberleſs Branches and minute Subdiviſions of the *Porta*: this Vein therefore, with re-

ſpect to the Liver, performs the Office of an Artery; and the Bile is here drawn off from the Blood by ſmall ſecretory Ducts or ſtraining *Tubuli*, ſent out from the minute Branches and ultimate Diviſions of the *Vena Porta*, after the ſame manner that the reſt of the Secretions are drain'd from the Arterys in all the other Glands.

Now to underſtand the Reaſon and Neceſſity of this peculiar and extraordinary Contrivance, it muſt be obſerv'd in the firſt Place, that all Parts and Organs in the Abdomen, thro which the Blood paſſes before it comes to the Liver, are abundantly ſtock'd, repleniſh'd, and every where diſſeminated with Glands; thro which a very great Part of the Lymph or Serum muſt be drawn off, before the Blood returns in the Veins, which unite in the *Porta*, and convey it to the Liver. And indeed, whoever conſiders the large and winding Courſe thro which theſe Arterys are diſpers'd in the Abdomen, and the Infinity of lymphatick Glands with which thoſe Parts abound, will hardly be able to doubt but that the Blood, from the continual drain of theſe Glands, muſt be depriv'd in a manner of all its Lymph or thinner part of its Serum before it enters the *Porta*: and 'tis evidently the Deſign of this large antecedent Drain of the Lymph, to prepare and diſpoſe the Blood for the Secretion and Diſcharge of the Bile in the Liver.

THIS will be farther confirm'd, if we conſider the Nature and Uſe of the *Spleen*, and what is there manifeſtly done to the ſame Purpoſe, and with the ſame Deſign as already mention'd.

THE Spleen is a large, ſoft and ſpongy Bowel, ſituated in the left Hypocondrium, between the Stomach and the Baſtard Ribs; it conſiſts of a very curious Contexture, Complication, and Congeries of Blood-Veſſels, Nerves and Lympheducts In this Bowel, the Blood-Veſſels, Nerves, and lymphatick Strainers, are in their ſeveral Branches and Subdiviſions convoluted and wound up into little Bundles, and included or bound about with their common and reſpective Coats or Coverings, a Congeries of which tied together by innumerable ſmall tranſverſe Fibres and Ligaments, conſtitute the main Subſtance and complicated Organization of the Spleen. Theſe vaſcular Convolutions and little complicated Bunches or Bundles of Blood-Veſſels, Nerves and Lymphaticks, are ſo very ſoft, yielding, and ſpongy, by reaſon of the largeneſs of the Veſſels, and the great Proportion of Fluids contain'd in them, that Anatomiſts have doubted, and ſtill diſpute whether they ought to be call'd Glands or no: but ſince they evidently perform the Office of Glands, and ſince a great number of Lymphaticks and Aqueducts ariſe from them, and convey their ſecreted Lymph or Serum, as well the groſſer as the more thin and limpid Parts of it, to

the *Receptaculum Chyli*; Men may call them what they pleaſe, for I am not at all concern'd about the Name, but only for the Nature and Uſe of them.

'Tis well known, that the ſplenick Artery is very large, and imports a greater Quantity and Proportion of Blood to this Bowel, than is uſually allow'd to other Organs of the ſame bulk and ſize: 'tis plain alſo from the ſoft, ſpongy, and open Texture of the Spleen, that the ultimate Branches and Diviſions of the ſplenick Artery and Vein, with their correſpondent Lymphaticks, are larger than in other glandulous Organs, and contain a greater Quantity and Proportion of their reſpective contain'd Fluids: from whence it follows, that the Secretion here made muſt be proportionally greater, and that a larger Quantity of Lymph or Serum, as well the groſſer as finer Parts of it, is drawn off and diſcharg'd in the Spleen, than in other glandular Organs of the ſame Dimenſions; and for this Reaſon, the ultimate Branches and Diviſions of the ſplenick Artery and Vein, are more diſtended and enlarg'd than in other Glands: that the Velocity of the Blood being hereby diminiſh'd, and conſequently the Blood making a longer ſtay in the Organ, the Secretion might be the greater, and the Blood be the more perfectly purg'd and drain'd of its Lymph, before it enters the *Aorta* by the ſplenick Vein, and paſſes to the Liver. And by this means, tho the Spleen is but a ſmall

Bowel,

Bowel, and contain'd within a narrow Compaſs, in proportion to the larger and more numerous Organs contain'd in the Abdomen; yet the Blood which paſſes from the Spleen to the Liver, is as much drain'd and depurated of its Serum, as that which is ſent off from the Meſentery, the Inteſtines, Pancreas, Stomach, *&c.*

But farther, 'tis very remarkable to the ſame Purpoſe, that becauſe the hepatick Artery is detach'd directly to the Liver, before it arrives at any other Glands, and conſequently carrys with it its whole Share and Proportion of Serum from the *Aorta*; therefore Nature has provided the Liver it ſelf, at its Entrance, with an Infinity of ſmall lymphatick Glands, by which the Serum in the hepatick Artery is drain'd off, before it penetrates and diſperſes thro the Subſtance of the Liver, and joins the Branches and minute Ramifications of the *Vena Porta* at the biliary Ducts. And thus we ſee what wonderful Art and Contrivance the Author of Nature has diſcover'd, in deriving off the firſt Drains and Sublimations of Lymph or Serum from the Blood, by paſſing it thro innumerable other Glands and Strainers, in order to prepare and diſpoſe it for the Secretion of the Bile in the Liver; the Reaſon and Neceſſity of which, to the Purpoſe of ſuch a Secretion as the Bile, muſt be next enquir'd into.

'Tis certain in Fact, that the common Lymph or Serum of the Blood, such as passes off most easily and universally in the Glands, contains but little Oil, Sulphur, and volatile Salt, but abounds more with fix'd Salts and Earths of different sorts, as is plainly prov'd from the Distillation of the Serum, and well known to the Chymists. This Part of the Serum therefore, is a very small, cooling, and diluting Liquor: but that Part of the Serum which coheres more strongly and intimately with the Globules, and which cannot be separated till after the other is drawn off, is strongly tinctur'd and plentifully saturated with Oil and volatile Salts, as Experience testifys: which volatile oily Quality in this last drain of Serum from the Blood, readily discovers it self both to the Smell and Taste, and may be confirm'd by any other proper Proof or Test to which it is brought.

From hence therefore the Reason of the foregoing Apparatus and Contrivance for the Separation of the Bile, is very plain and obvious; for since a Liquor was here to be separated, plentifully stock'd with the strongest Oil and volatile Salts of the Blood, and since this Part of the Serum has the strongest and most intimate Union and Cohesion with the *Crassamentum* or Blood-Globules, this strong, hot, and volatile oily Serum cannot be separated from the Blood, till the colder, weaker, and more fluid Parts, or the common circulating Serum be first drawn off and dis-

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charged; and therefore it was neceſſary to make ſuch a Drain of the common Serum from the Blood by the other Glands, according to the Method of Nature already conſider'd and explain'd, before the Bile in the Liver could be ſeparated and drawn off; which is ſuch a curious and entertaining piece of natural Chymiſtry, as cannot but affect any one who conſiders it, with Wonder and Pleaſure.

FROM hence the Reaſon is plain, why ſo great Quantity of Blood is paſs'd thro the Liver, for ſo ſmall a Secretion as is that of the Bile; for ſince this part of the Serum which abounds with this ſort of Oil and Salt, has the cloſeſt and moſt intimate Coheſion with the *Craſſamentum* or Globules, a great Quantity of Blood muſt paſs, in order to draw off but a very ſmall Quantity and Proportion of this Liquor; and which could never have been ſecreted at all in any of the glandular Pipes, had not the lighter and leſs cohering Parts of the Serum been firſt drawn off, as has been ſhewn.

THIS then is the Wiſdom and Providence of Nature, in drawing off a Liquor from the Blood, of all others under ſo ſmall a Quantity, the moſt neceſſary and important to animal Life. For this bilious Secretion is a potent Diſſolvent, a wonderful Precipitant, and a moſt congenial and benign Cathartick: in ſhort, this Liquor is the great refiner and purifier of the Chyle, the cleanſer of the Bowels,

els, and the ſtrengthner and preſerver of the Stomach in its Office of Digeſtion: and where this Secretion is either not made in the Liver, or not brought to and mix'd with the Chyle in its natural and due Quantity and Proportion, all the animal Liquors are preſently diſpos'd to Corruption, Putrefaction, and Stagnation.

THERE remains one thing yet farther, of great Conſequence to be conſider'd and explain'd with reſpect to theſe glandular Secretions; and that is, the Nature and Uſe of the Lymph, or the Reaſon of that large and continual Drain of Serum from the Arterys, which is inceſſantly returned, and poured in again upon the Blood in the Veins: this is a Phænomenon which 'tis impoſſible to overlook in the Animal Oeconomy; and all the Anatomiſts accordingly take notice of it: but yet ſo little has been ſaid about it as to the Reaſon and Neceſſity of it, that one would think it as impoſſible to be accounted for, as it is not to be taken notice of and obſerv'd.

BUT to ſhew the true Uſe and Deſign of this lymphatick Circulation, let it be here remember'd what has been proved at *Prop.* 1. that the main Heat, Fervor, Efflatus, and Activity of the Blood, are retain'd and reſide in the Globules; and next to theſe, that Part of the Serum which has the ſtricteſt Union and cloſeſt Coheſion with the *Craſſamentum*, has the greateſt Heat and Fervor, as being plentifully

tifully saturated with volatile oily Salts, and consisting of very subtile and active Parts, deriv'd from the Globules themselves.

But the other common circulating Serum, which freely and universally passes the Glands, is much smaller, weaker and thinner, and is plainly a cooling diluting Liquor, otherwise than as it is continually in some Degree heated from the Globules, and their active volatile oily Salts.

This Serum therefore, to prevent its being over-heated and coagulated in the Arterys, is continually drain'd off thro the lymphatick Glands; and having been for some time drawn off and separated from the Globules and hotter Serum, carry'd a roundabout Course in the Lymphaticks with a slower Motion; and being thereby very much cool'd and condens'd, it is return'd upon the same Mass in the Veins to cool and dilute the Blood: by which means, the natural Heat of the Blood is abated, suppress'd, and kept within due Bounds. Which natural Heat proceeding from the Globules and active Oils and Salts, would be otherwise still increasing, and soon become unsufferable, and inconsistent with the Animal Life.

This I take to be the true Intention of the circulating Lymph, to draw off the over-heated Serum from the Arterys, and cool it in the Lymphaticks; to the end, that being continually returned fresh and cool, it may serve to temper and qualify the natural Fervor

vor of the Blood, and retain it within its due and proper meaſure. And that this is really ſo in Fact, will be farther evident, if we conſider how the Caſe ſtands in Fevers, where the Secretions are ſtopt, and this drain of the Lymph for a time ſuſpended and interrupted. For by the Heat and Rarefaction of the Blood in Fevers, the Blood-Globules are inlarg'd, and imbibe and retain a great Part of the Serum, while the reſt of the Serum thickens with the Heat, and ſtrongly adheres to the *Craſſamentum*: In which Caſe, all the Secretions, and particularly that of the Lymph or Serum, muſt neceſſarily be diminiſh'd; in proportion to which Diminution, we find the Heat of the Blood always increaſes, till by proper Methods of cooling, diluting and condenſation, the Lymph or Serum is prepar'd and diſpos'd to ſeparate and run off from the *Craſſamentum*; and then the lymphatick Secretion and Circulation again taking place, there enſues a Solution of the Fever; and the morbifick Heat being qualify'd, ſuppreſs'd and reſtrain'd, the Blood returns to its natural Conſtitution and Temper.

PROPOSITION IX.

THE continual Paſſage of the Blood thro the ſmall capillary Arterys, and of the Serum thro the minute glandular Tubuli, *is the great Principle of Attenuation in the Animal Oeconomy, by which the Blood and animal Fluids have their Parts moſt minute-*

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ly broken, ſeparated, and kept from coagulating, or running into large concreted Maſſes.

How exceedingly the Blood and animal Liquors muſt be divided and attenuated by a continual and repeated Draining thro the ſmall capillary Arterys and glandular *Tubuli*, will appear from the following Computation. The Diameter of a common Drop of Water is about $\frac{1}{6}$ of an Inch, and the mean Diameter of a Blood-Globule as it ſwims freely in the Serum, I have found by Obſervation to be $\frac{1}{1\,0}$ of an hair's Breadth; 300 of which Breadths make an Inch: and conſequently the Diameter of ſuch a Blood-Globule will be only $\frac{1}{3\,0\,0\,0}$ of an Inch; and the Magnitude of the Drop will be to the Magnitude of the Blood-Globule, as the Cube of $\frac{1}{6}$ to the Cube of $\frac{1}{3\,0\,0\,0}$; or as the Cube of 600 to 1: that is, as 216000000 to 1. But many of the Blood-Globules are much leſs, ſo as not to exceed $\frac{1}{2\,0}$ of ſuch an hair's Breadth; of which Globules therefore there muſt go 1000000000 to make up the bulk of a common ſmall Drop.

But 'tis certain, that the largeſt of the glandular ſecretory Ducts muſt be ſmaller than the leaſt of the capillary Arterys; becauſe the leaſt of the evaneſcent Arterys is capable of admitting the Blood-Globules, which the largeſt of the glandular Tubes cannot in their natural State, or without ſuch Violence, the

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Conſequence of which muſt be bloody Secretions.

FROM hence therefore 'tis plain, the Blood and animal Fluids muſt paſs thoſe numberleſs exceedingly minute Tubes thro which they are continually drain'd, in Particles as fine and ſubtile as any Steam or Vapour can be imagin'd: and while their Parts are thus ſeparated and divided by the corpuſcular attractive Powers of theſe minute *Tubuli*, 'tis Attraction and Colature is the great and univerſal Principle of Attenuation in the Animal Oeconomy; by which the Parts of the Blood and animal Fluids are ſeparated, comminuted, and kept from coagulating, or running into large concreted and cohering Maſſes.

PROPOSITION X.

THE expurgatory Secretions are augmented by Watching and Exerciſe, and diminiſh'd by Sleep and Reſt: but on the contrary, the lymphatick Secretions are increaſed by Sleep and Reſt, and leſſen'd by Watching and Exerciſe.

THE Truth of this *Propoſition* will ſufficiently appear from the following Obſervations and Phænomena.

THE moſt conſiderable of the expurgatory Secretions, and to which all the reſt bear but a ſmall Proportion, are thoſe which paſs off by Perſpiration and Urine. Now 'tis evident in Fact, from all the Experience and Ob-

Obſervations we are furniſh'd with, that both theſe Secretions are leſſen'd by Sleep and Reſt, and augmented by Watching and Exerciſe. *Sanctorius* in his *Aphoriſms*, grounded on plain Facts and Experiments, confirms this beyond all Exception: But I ſhall chuſe to confine my ſelf here to the Statical Obſervations and Experiments of our own Countryman, the learned Dr. *James Keil*, which muſt be ſuppoſed to be moſt accommodated to our Conſtitutions; becauſe they were all made in our own Climate, and under the ſeveral Degrees of Heat and Cold with us, and thro a ſucceſſive Courſe of ten Years. From all which Experiments, made with great Aſſiduity and Care, it appears, that tho both the foremention'd Evacuations are ſubject to certain Augmentations and Diminutions, on the account of different Degrees of Heat and Cold, and the different regimen and way of Living with reſpect to the Non-naturals; yet in a mean Proportion and in a healthy State, the Quantity of perſpirable Matter which paſſes off by Day, is to the Quantity of the ſame Secretion in the ſame time by Night, as 3 to 2: that is, the Quantity perſpir'd in a given time in a ſtate of Sleep and Reſt, is but $\frac{2}{3}$ of the Quantity perſpir'd in the ſame during a ſtate of Senſation and Action. And from the ſame Experiments it appears farther, that the urinary Diſcharge is likewiſe increas'd and diminiſh'd under the foregoing Circumſtances reſpectively, and nearly in the ſame pro-

proportion with that of Perſpiration. From whence 'tis evident in Fact, that theſe two moſt conſiderable of all the expurgatory Secretions, are leſſen'd by Sleep and Inaction, and augmented by Senſation and voluntary Motion.

THE Secretions of the *Saliva*, of the *Mucus* of the Noſe, and of the Excrements thro the Inteſtines, being but comparatively ſmall in a natural State, cannot be ſo eaſily computed and judg'd of by Obſervations and Experiments: But when either of theſe happen upon any occaſion to be increas'd beyond their natural and ordinary Quantitys, their Diminution and Remiſſion by Sleep, is as great and remarkable as of the two former.

'TIS matter of common Obſervation, that they who by taking Cold diſcharge a great Quantity of Saliva and Mucus, have this Evacuation very much abated, and in a manner quite ſtop'd and ſuſpended during the time of Sleep; but the ſame Diſcharge immediately comes on again as ſoon as it is excited, and as it were ejected and forc'd off by the Stimulus of Senſation, and voluntary Motion in a waking State.

THUS likewiſe in thoſe who are put under a Salivation by Mercury, the Flux is very much remitted, and in a manner ſuſpended in the time of Sleep; by which it is diverted, turned inward, and carry'd about by the circulatory or lymphatick Glands; but comes on afreſh, as ſoon as the Perſon awakes into a

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ſtate of Senſation and Action. And the ſame thing is obſervable in a Diarrhæa, which is ever found to leſſen and abate during the time of Sleep, after the ſame manner as in all the other expurgatory Secretions.

EVERY body knows the Power of Opium in eaſing Pain, procuring Sleep, and ſtopping a Diarrhæa; but they are very much miſtaken, who attribute this laſt Effect to any occult Quality in the Opium, whereby it is ſuppoſed in ſome ſecrete inexplicable manner to thicken and ſopify the Blood and Humours, and at the ſame time to charm, ſooth, and pacify the diſturb'd enraged animal Spirits: for indeed, all the Effects of Opium in leſſening and abating the expurgatory Secretion, are owing to the Sleep which it procures, or that eaſy indolent State of ecſtatick Quietude which is equivalent to Sleep; and the ſame Sleep or Indolence naturally coming on, or procur'd any other way, would have the ſame Effects. For let a Perſon under a Diarrhæa ſleep naturally, and it may be obſerv'd, that the Matter of the Secretion which was before thin, ſharp, and acrid, and which flow'd from the Orifices of the excretory Ducts in great abundance, will, during the time of Sleep, abate very much of its Quantity and Velocity; and as a Conſequence of this, it muſt thicken and ſopify by its ſlower Motion and longer ſtay in the ſecretory Canals.

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FROM theſe Obſervations and Phænomena, 'tis evident, that all the expurgatory Secretions are leſſen'd by Sleep and Quietude, and augmented by Watching and Exerciſe: Now from the ſame Reaſon, and by the ſame Neceſſity it muſt follow, that the Secretions of the lymphatick Glands are increaſed, while the other is diminiſh'd, and *vice verſa*; ſince the leſs the Quantity of Serum is which drains off from the Blood by the expurgatory Secretions, the greater will be the Quantity which remains to be taken up, and ſtrain'd off by the circulatory or lymphatick Glands.

PROPOSITION XI.

THE lymphatick circulatory Secretions, by Sleep are increaſed in a greater Proportion than that in which the Evacuations, or expurgatory Secretions are diminiſh'd.

THE mean Quantity of Perſpiration in a Day, or 24 Hours, is 31 Ounces; and the mean Quantity of the urinary Diſcharge, is 38 Ounces: and if we ſuppoſe the Saliva, the Excrements by Stool, the Mucus of the Noſe, *&c.* to be two Ounces, then will the Quantity of Urine be equal to all the other Evacuations. And becauſe the Perſpiration and Urine are diminiſh'd in the time of Sleep nearly as 2 to 3, 'tis evident that, *cæteris paribus*, the lymphatick circulatory Drain will be increaſed in the ſame Proportion, by the laſt *Propoſition*. But there is another very con-

conſiderable Cauſe of increaſing theſe internal lymphatick Secretions in the time of Sleep, and that is the increas'd Velocity of the Blood, by which a greater Quantity of Matter will be carried to the Orifices of the ſecretory Ducts in the ſame time. 'Tis certain in Fact that the Pulſe is accelerated, and conſequently the Velocity of the Blood increaſed by Sleep; this Acceleration is not fix'd to any one conſtant Ratio, yet 'tis confin'd within certain Bounds; ſo that a healthy Perſon, whoſe Pulſe beats 80 times in a Minute by Day, ſhall in the Night, or while he is ſleeping, beat from 80 to 112 times in a Minute: but the mean Proportion, and what is moſt common, is that of 80 to 96, which is the Proportion of 5 to 6. Now from both theſe Cauſes together 'tis manifeſt, that the circulatory or lymphatick Secretions in the time of Sleep, will be increas'd in a greater Proportion than that in which the expurgatory Secretions are diminiſh'd.

PROPOSITION XII.

THE Urine which is brought continually into the Bladder, is derived partly from the Stomach it ſelf immediately by direct Paſſages, and partly from the ſecretory Ducts of the emulgent Arterys, by which it is ſtrain'd from the Blood thro the Kidneys.

THAT there are ſuch direct Paſſages from the Stomach to the Bladder, is proved from the following Experiments and Phænomena.

1. WHEN the Stomach, with the whole Contents of the Abdomen, is taken out of an animal Body after it is juſt open'd; if the Stomach be fill'd with Water, while the Parts are yet warm and wreaking, the Liquor will paſs out of the Stomach into the Bladder, which will viſibly receive the Fluid, and be fill'd with it as the Stomach emptys it ſelf: Whence the Paſſage of the Liquor from the Stomach immediately, is evident in Fact.

2. A LIGATURE being made upon the Ureters, while the Animal is living, and the Blood continues to circulate, tho this muſt cut off all Communication from the Kidneys to the Bladder, yet any Liquor with which the Stomach is fill'd will paſs into the Bladder: From whence 'tis evident, that there are direct Paſſages from the Stomach to the Bladder, without communicating at all with the Kidneys, or with the Blood in its common Courſe.

3. THIS directer Paſſage appears from the Nature of the Urine firſt made after drinking a good Quantity of any Liquor: For the firſt Urines are always thin, clear and limpid, little differing in any of their ſenſible Qualitys from the Nature of the Liquor it ſelf; being plainly nothing elſe but the thinneſt and moſt aqueous Parts of the Liquor, drawn off directly from the Stomach; whereas the Urines of the laſt Diſtillation, or ſuch as paſs

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the common Courſe of the Circulation, are ſtrongly tinged and ſaturated with the Salts and Recrements of the Blood, and give plain Proofs that they have taken another way, and that they come to the Bladder from the Blood thro the Kidneys in the common Courſe.

SCHOLIUM.

THE general Deſign of Nature in theſe firſt urinary Drains directly from the Stomach, is to prevent any ſudden Plethora, or immoderate Diſtenſion of the Blood-Veſſels upon drinking. For ſhould the whole Quantity of Liquor which is or may be taken into the Stomach, have been left to paſs thro the Lacteals into the Blood, this muſt very frequently and ſuddenly have induced a preternatural Fulneſs and Diſtenſion of the Veſſels; the Conſequence of which, as is eaſy to conceive, muſt on many accounts have been very fatal: and therefore the Author of Nature has wiſely contrived a Remedy againſt this Evil, by providing the Animal Machine with theſe firſt and direct urinary Outlets, to prevent any too ſudden or violent Surcharge upon the Blood-Veſſels and Lymphaticks.

PROPOSITION XIII.

TO explain the Origin, Formation, and Conſtitution of glandular Diſeaſes.

THE original ſecretory Ducts or glandular Strainers, thro which the Serum or Lymph

is drawn off from the Blood in the Arterys and their ſecondary conveying Pipes, by which it is propagated from the Glands and diſtributed to its ſeveral Receptacles and Outlets; being extremely minute, conſiſting of very thin and tender Coats, and endu'd with but a very ſmall degree of muſcular Force; are, upon theſe accounts, the moſt liable to Obſtructions, immoderate Diſtenſions, Eroſions and Dilacerations, of any in the whole Body.

And from hence a multitude of Symptoms ariſe, and diſtinct Diſeaſes are form'd, which have been hitherto either ſo little underſtood or ſo odly explain'd, that this morbifick Conſtitution has been generally allow'd as the *Opprobrium & Flagellum Medicorum*, the common Reproach and Scourge of Phyſicians: for all the Diſeaſes under this general Conſtitution, excepting perhaps a Dropſy and a *Phthiſis*, or Ulceration of the Lungs, have been call'd *Nervous*, and aſcrib'd to the intemperate Sallys, the irregular Exploſions, and the eccentrick Motions of the diſturb'd animal Spirits; which is a Cauſe certainly more myſterious than any Diſtemper in the whole Body.

But that I may, at leaſt in ſome meaſure, free this Part of the Theory and Practice of Medicine from ſuch Generality, Confuſion and Uncertainty, I ſhall here conſider the principal morbifick Diſpoſitions of the Lymph and glandular Secretions: and this may perhaps ſerve to account for ſome of the moſt

abſtruſe Phænomena of Diſeaſes, without recurring to a Cauſe ſtill more abſtruſe than the Phænomena themſelves.

Now the Lymph or Serum of the Blood, which is continually draining off thro the lymphatick and expurgatory Glands, may become Morbifick, either on the account of its *Quantity* or *Quality*; and both theſe morbifick Conſtitutions of the Serum, reſpecting either its Quantity or Quality, depend ſo much on the urinary and biliary Secretions, that the one cannot be underſtood or explain'd without the other: and therefore I ſhall conſider them both together, that their original morbid Conſtitutions, and their ſeveral Phænomena may be ſeen in their proper genuine Production and Formation.

1. THEREFORE, the urinary Pipes and Aqueducts from the Stomach and Blood into the Bladder being the principal Water-drain, by which the greateſt Part of the Liquors taken in are diſcharg'd again out of the Body; where theſe are obſtructed, and the Quantity of Urine conſiderably diminiſh'd, the neceſſary Conſequence of this muſt be a Surcharge of Serum in the Blood, which running off too faſt upon the Glands and Lymphaticks, and overſtretching, dilating, and diſtending them, a Dropſy muſt enſue: and from hence there will ariſe different Appearances and Symptoms, according to the different State and Circumſtances of the overſtretch'd diſtended Glands and Lympheducts, and the

particular Parts upon which the principal Bulk and Surcharge of the Water is thrown.

THE Meſentery and the Caul, being all glandulous and abounding with an infinity of Lymphaticks, thro which the largeſt Quantitys of Lymph are drawn off from the arterial Blood, are therefore moſt liable and the firſt diſpoſed to a Diſtenſion and Tumefaction, upon any great or long continu'd Obſtruction and Diminution of the urinary Drains; from whence the Inundation ſoon ſpreads, and diſtends the Spleen, the Liver, Stomach, and all the Parts of the Abdomen; and laſtly, the whole Body is ſwell'd and bloated from Head to Foot.

BUT this univerſal Dropſy, or *Anaſarca*, is often prevented by a worſe Accident; for it frequently happens, that the Liver, Spleen, Caul and Meſentery, ſome or all of them corrupting, and their Lymphaticks breaking, the Water is let out into the Cavity of the Abdomen; which renders the Caſe deſperate. For tho any preſent Load of Water may be let out of the Belly by Tapping, yet it will be ſtill collecting and filling up again from the broken Lymphaticks; till Nature being quite waſted and worn out, the Patient dies; having all his Bowels and the principal Organs of Life ſoak'd, tainted, and putrefy'd in the ſtinking corrupt ſtagnating Water.

THESE two *ſorts* or rather *degrees* of a Dropſy, the *Anaſarca* and *Aſcites*, manifeſtly conſiſting in a Redundance of Water, from

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an Obſtruction of the urinary Pipes and Strainers, the animal Spirits have not been ſo much blam'd; and every body allows the Diſtemper to be owing, not to highly refin'd rectify'd Spirits, but to ſtinking, corrupt, and putrefying Water.

But there is another ſort of Dropſy, which lying more latent and conceal'd, has been generally taken for a pure nervous Caſe, and its Symptoms accounted for from the *Doctrine* of *Animal Spirits*; an Hypotheſis, ſerving in Phyſick to explain all thoſe Diſeaſes which the Phyſicians have been ignorant of or ſurpriz'd at, like the common Refuge of Conjuration or Witchcraft among the Vulgar. The Dropſy which I here intend, is the internal *Hydrocephale*, or Dropſy of the Brain, of which the Symptoms and peculiar Phænomena are ſo very different from thoſe of an *Anaſarca* and *Aſcites*, that they are commonly aſcrib'd to a quite different Cauſe, to the great Detriment of the Patient, and Diſappointment of the Phyſician.

'Tis well known that the Brain is provided with a great number of lymphatick Glands: for beſides the Pineal, the Pituitary and Choroidal Glands, which are ſufficiently viſible and remarkable, the *Pia Mater* is all over bedeck'd and interlac'd with an infinity of ſmall Glands of the lymphatick Kind, which in their natural State cannot be ſeen without a Microſcope; but when this Membrane has been ſoak'd ſometime in warm Water, or

when these Glands are preternaturally tumefy'd and distended in a *Hydrocephale*, they are visible enough to the naked Eye. Now all the lymphatick Glands of the Brain, thro which the Lymph is drawn off from the ultimate Branches of the cervical and carotide Arterys, uniting in larger Canals, convey their secreted Lymph to the jugular Veins, where it is empty'd into the Blood. And this is sufficiently evinced by injecting any tinged Liquor thro the *Infundibulum*, where the Lymphaticks of the Brain unite; which Liquor will freely pass into the jugular Veins, but cannot in the natural State and Situation of the Organs pass any other way.

When these Glands and their Lymphe-ducts are obstructed, so as not to send off their Lymph to the Veins as aforesaid, the Consequence is a Dropsy of the Brain, or an internal *Hydrocephale*; of which the Symptoms will be various, and more or less severe, according to the Nature of the Obstruction, and the Quantity of the Lymph detain'd and pressing upon the Nerves and Blood-Vessels; while the Glands and their Lymphaticks are only immoderately distended and dilated, but not broken, the Symptoms are Heavineſs, Lassitude, and a general Weakness of the Muscles; a listless Unconcernedness about things, Drousiness, and an almost continual Disposition to Sleep, with an unusual Tenderness or Incapacity of bearing the least Excess of Heat or Cold, either with respect to the exter-

external Air, or the internal uſe of Drinks and Medicines. When the Obſtruction, Dilatation and Diſtenſion become greater, the Diſeaſe diſcovers it ſelf in vertiginous and paralytick Symptoms, and diſpoſes to Lethargys, Epilepſys, Apoplexys, and *ſpaſmodick Deliquia:* But when theſe Glands and Lymphaticks inflame, break, and let out their contain'd Lymph upon the Brain, or between the Meninges, the Caſe is altogether deſperate, and the Patient ſoon dies paralytick, convulſed, and under a ſtupid drouſy ſort of Raving.

HOWEVER, while the Diſtemper is only growing, and before the Lymphaticks break and extravaſate the Water upon the Brain, there is hope of a Cure, provided the moſt effectual Methods are taken to derive and draw off the Water from the Head, by long continued moderate Purgings, Iſſues, Setons, Bliſters, *&c.* but all volatile oily Salts, ſtrong ſpirituous Liquors, heating Cordials, and every thing which determines the Blood and Humours in a greater Quantity than ordinary to the Head, are moſt certainly hurtful, how much ſoever they may be ſometimes uſed and cry'd up, under a pretence of awakening and rouſing up the animal Spirits, and delivering them from their ſuppoſed Oppreſſion and Suffocation. But,

2. TO conſider another Effect of this morbifick urinary Secretion: It ſometimes happens, that the primary Drains, and thinneſt Part of the Urine, paſs off very plentifully

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in ſufficiently large, or perhaps too great Quantitys; while the groſſer Salts, Earths, and other thick and gritty Recrements, which ought to be ſtrain'd off and diſcharg'd thro the Kidneys, are retain'd in the Blood from ſome Weakneſs, Dilatation, or Obſtruction in the renal Glands, which cannot make this due and neceſſary Secretion: And this groſs, ſalt, and ſabulous Matter, being retain'd in the Blood and mix'd with the Serum, muſt paſs together with the Lymph thro the other Glands and lymphatick Strainers, in a preternatural way; and from hence the Glands in different Parts being gradually fill'd with this groſs urinous Salt and ſlimy Sabulum, will at length be totally obſtructed, and very much dilated and diſtended with it, and thereby form various ſorts of œdematous and ſchirrous Tumors; which Tumors at laſt ſuppurating and running into Ulcers, produce a great variety of different Symptoms and Appearances, more or leſs ſevere and grievous, according to their ſeveral degrees of Malignity, and the particular Parts affected: and this is what I chuſe to call in general *the Scorbutick Conſtitution*. Of which general Scorbutick Conſtitution, I ſhall here conſider ſome of the principal Modifications and Phænomena.

In the firſt Place therefore, the Serum of the Blood being plentifully ſtock'd with this groſs, ſalt, and ſlimy Sabulum, which cannot be drain'd off by the Kidneys, a great Proportion of the thickeſt and groſſeſt Part of it muſt

muſt neceſſarily paſs thro the Spleen; in which the Blood-Veſſels and Lymphaticks are the largeſt of any other glandulous Organ of the Body: and conſequently while the thinner Parts are carried off, and the thicker and groſſer lodg'd upon the Glands, the Spleen will be firſt obſtructed, indurated and tumefy'd, from ſuch a Cauſe as we are now conſidering.

In the next Place, the Meſentery, in which an Infinity of lymphatick Glands are interwoven, and complicated thro its whole Subſtance, will conſequently be obſtructed, harden'd and tumefy'd, from the ſame Cauſe and by the ſame Means as before; and from this Diſtenſion and Tumefaction of the Meſentery, the Inteſtines muſt be compreſs'd and conſtipated, their periſtaltick Motion, or the muſcular Action of their Coats leſſen'd and diminiſh'd, and the Protruſion and Expulſion of the Excrements hinder'd and obſtructed: from whence the Stomach and Bowels will be fill'd with a windy Flatus, occaſioning ſour, hot, ſharp, acrid and ſtinking Belches, Cholick Gripes, immoderate Diſtenſion of the Stomach and *Viſcera*, aſthmatick Suffocations, and very often a ſort of drunken, delirious, or maniacal ſtrength and wildneſs of Imagination, from the immoderate Afflux of the Blood to the Head. On the other hand, while the Inteſtines are thus compreſs'd and conſtipated by the tumefy'd indurated Meſentery, any ſtrong Catharticks, low, cooling, cleanſ-

cleanſing Liquors, acid mineral Oils and Spirits, and whatever tends to move the Blood and Humours downwards, by irritating and ſtimulating the Stomach and Inteſtines, which have in great meaſure loſt their muſcular natural Force, muſt produce Faintneſs, Tremblings, *Deliquia*, a low Pulſe, cold Sweats, and a terrify'd Imagination, impreſs'd with all the Images and Ideas of Fear and Grief.

THE Spleen and Meſentery, to which we may add the *Epiploon*, being thus tumefy'd, and their Glands obſtructed, the Lymph cannot be drawn off in ſufficient Quantitys from the Arterys; and conſequently the Blood will be ſent into the *Vena Porta* and to the Liver, not ſufficiently drain'd and depurated of its thinner Serum: from whence the Liver, inſtead of ſecreting the pure Bile, will drain off only a low, watry, ſalt, and ſabulous Liquor, coming near to the Nature of Urine; while the proper volatile oily Salts of the true and natural Bile will be left in the Blood: and theſe mix'd with the groſſer fix'd Salts and ſlimy Sabula of the Urine, which cannot paſs the Kidneys, ferment with and corrupt the whole Serum of the Blood, by rendring it hot, ſharp, acrid, pungent, extremely penetrating, and in a manner corroſive; and the Serum thus corrupted, fuſed, and ſharpen'd, muſt diſpoſe the Tubercles and Tumors of the Spleen and Meſentery, to ſuppurate and run off into putrefying Ulcers: from which Eroſion and Ulceration, there muſt enſue a

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Tabes, an Hectick, and a general wasting or consumption of the Flesh and Fat. From all which Symptoms thus deriv'd from their natural Production and original Cause, 'tis plain that this which has been here describ'd is the hypocondriack and hysterick Constitution; and that they who are so affected, labour under a true and proper splenick and mesenterick Scurvy.

When the same urinous, salt, slimy, and sabulous Matter happens to be thrown upon the Glands of the Bronchia, it produces the Tubercles, Tumors, and Abscess of those Glands, or an Ulceration of the Lungs, which is properly a bronchial Scurvy: And here where the true Cause appears, the animal Spirits are no longer blam'd, as they generally are while the Scene is acted deeper, and the Disease lies more latent in the glandular Organs of the Abdomen.

In short, there are no Glands throout the whole Animal Body, but what may be affected after the same manner, and their Blood-Vessels, Nerves and Lymphaticks tainted, eroded and ulcerated by this salt, sharp, sabulous, bilious, and corrosive Serum, which often corrupts, putrefies, and eats off the Ligaments and Bandages of the Joints, dissolves the Union of the Cartilages and Bones, and soaks thro and swells the Bones themselves, cankering, corrupting, and mortifying them. The Leprosy in all its dismal Appearances, and the *Lues Venerea*, are owing

owing to the ſcorbutick Cauſe rais'd to a higher Malignity.

PROPOSITION XIV.

TO explain the Origination, and eſſential Conſtitution of FEVERS *in general.*

IN order to come to any Certainty about the natural Production, eſſential Conſtitution and Cure of Fevers, it will be neceſſary to conſider the peculiar Characteriſticks of a Fever, or thoſe common Symptoms which attend all Fevers, and by which a Fever is outwardly and ſenſibly diſtinguiſh'd from all other Diſeaſes. Now theſe common Characteriſticks, or viſible Appearances which in ſome degree or other ſenſibly attend every Fever, are theſe which follow.

I. A QUICK, unequal, irregular Pulſe.

II. A LABORIOUS and diſturb'd Reſpiration.

III. AN equally fluid, high colour'd ſhining Urine, with a Diminution of its Quantity, eſpecially in the Febrile Paroxyſm.

IV. A PARCHEDNESS and dryneſs of the Tongue, Mouth and Throat, with a clammineſs and viſcidity of the Saliva, attended with a conſequent heat and thirſt.

V. AN inflammatory painful Reſtleſſneſs, preventing, interrupting, or diſturbing the natural Sleep.

VI. Loss

VI. Loss of Appetite, and a general Nauſea and Reluctancy of the Stomach againſt every thing but thin diluting Liquors.

I DO not pretend that all theſe Symptoms are equally apparent in every Fever, tho I think there is no Fever but where they are all to be found in ſome degree or other; and ſome of them, at leaſt, ſo diſtinct and ſenſible, that every judicious Obſerver will eaſily pronounce whether the Perſon has a Fever or not.

NOW from theſe Symptoms 'tis manifeſt, that in every Fever there is a general Obſtruction and Diminution of the glandular Secretions; I mean, that a great Part of the Lymph or Serum of the Blood, which ought to be continually drain'd off, both by the conſervatory and expurgatory Glands, is during the Fever ſo retain'd in, and cloſely united to the Maſs, that it circulates together with it in the Blood-Veſſels ſtrictly ſo call'd, *i. e.* in the Arterys and Veins.

TO ſhew that this is really and in Fact the State and Conſtitution of the Blood in the Production and Formation of a Fever, it will be neceſſary here to apply the general Principle to the fore-mention'd particular Symptoms; by which it will be evident, that all thoſe Phænomena or ſenſible Appearances of Fevers, are the juſt and adequate Effects of ſuch a Cauſe. For,

1. THE Lymphaticks being obſtructed, and thereby the Influx of the cool'd, diluted Serum from the conſervatory Glands being intercepted, 'tis manifeſt that the Blood upon this occaſion muſt acquire a preternatural Heat; and from hence the Serum of the Blood will become too viſcid, glutinous and tenacious, which is the well-known Conſequence of its being over-heated.

2. THE Serum being thus retain'd by its heat and viſcidity in the common Maſs, and not flowing in a ſufficient Quantity and a due Velocity in the Lymphaticks and ſecretory Ducts of the Glands, 'tis plain that a greater Quantity than ordinary of the Fluid muſt now circulate thro the Blood-Veſſels, *i. e.* the Arterys and Veins. And from hence partly by the increas'd Quantity, and partly by the Heat and Rarefaction of the Blood, there muſt enſue a Plethora of thoſe Blood-Veſſels; and from hence a preternatural Diſtenſion of the ſmall capillary Arterys in the Glands and Muſcles, with Heat or inflammatory Pain.

3. THE hot viſcid rarefy'd Blood, diſtending and inflaming the Glands and muſcular Fleſh, muſt act as a *Stimulus* upon the Nerves or muſcular elaſtick Fibres, and excite them to ſtrong and violent Vibrations or Efforts, in order to remove the increaſed Weight and Reſiſtance of the Blood, and carry on the Circulation. And theſe Vibrations and Efforts of the Nerves will be different and unequal,

equal, according to the Nature of the *Stimulus*, and the different Parts affected by it. And this must produce a quick irregular Pulse, and a laborious and disturb'd Respiration.

4. The Serum being detain'd by its Heat and Viscidity in the Blood, and not passing as usual thro the Lymphaticks and secretory Ducts of the Glands, but a small Quantity of the Saliva will be shed off; which therefore by its slow Motion will grow thick and clammy: and by means of the small capillary Arterys, distended with hot rarefy'd Blood every where dispersed, and pressing upon the salival Glands, the Tongue, Mouth and Throat will be parch'd and dry'd, the Saliva harden'd and incrustated about the Tongue and Palate, and produce a Heat and Thirst. And for the same Reason 'tis evident, that only the thinner and more fluid Parts of the Serum will be strain'd thro the Kidneys: and consequently the Urine will be small in Quantity, of an high florid Colour, and with little or no Sediment or Separation of its Parts.

5. In this Case, and for the Reasons already mention'd, the Stomach being heated and inflam'd with the hot rarefy'd Blood, every thing contain'd in it will be apt to ferment, rarefy, and work up into an indigested Flatus; and the Lacteals at the same time being compress'd and constipated by the distended turgid Blood-Vessels, will admit of nothing from the Stomach but what is very thin and fluxile: and therefore the work of

Digeſtion will be interrupted and perverted, Nature will loath and reluct againſt any thing of Food or Aliment, and the Perſon will covet nothing but thin diluting Liquors.

Now after this account of the general Origination and Conſtitution of Fevers that are true and ſimple, it will be neceſſary to conſider the natural Solution of ſuch Fevers, and by what means the Buſineſs is effected, when the Cure is left to and perform'd by Nature alone, without the Aſſiſtance of Art: And this is of ſuch Conſequence, that it will be impoſſible to determine any thing certain about the Cure of Fevers, without carefully following the Footſteps of Nature, and making that our principal Guide and Rule.

DURING the Riſe and State of a true Fever, ſuch as I am now conſidering, the expurgatory Secretions are in a great meaſure ſuſpended, or very much leſſen'd and abated: the Saliva flows but in ſmall Quantitys; the external Surface of the Body is parch'd and dry, with little Appearance of Sweat or Perſpiration; the firſt Urines, or ſuch as at other times are drain'd off directly from the Stomach to the Bladder, are now quite ſtopp'd; the fix'd Salts and earthy Sediments of the Blood, which uſually paſs off by the Kidneys, are now kept back, and only a ſmall Quantity of the heated Serum paſſes theſe urinary Diſcharges. That this Detenſion of the ſerous Evacuations is the neceſſary Conſequence of a Fever, we have ſeen already,

and by what means it comes about: what now remains is to ſhow that this, which is the *neceſſary Conſequence*, is alſo the *natural Cure*; or the Method by which Nature, *i. e.* the Machine, relieves and ſuccours it ſelf, provided the Enemy be not too ſtrong.

FROM what has been ſaid I preſume it may be ſufficiently evident, that the Heat, Rarefaction, and Viſcidity of the Blood, muſt be neceſſarily increas'd upon any Obſtruction of thoſe Lymphaticks which are deriv'd from the conſervatory Glands, and by which the heated Serum ought to be receiv'd from the Arterys, and return'd cool'd and diluted upon the Blood in the Veins; and conſequently that ſuch an *Obſtruction* or *Diminution* muſt produce a *Fever*. Now in this Caſe, ſhould the Serum or thinner part of the Blood be thrown off too faſt in any of the expurgatory Secretions, the remaining part of the Maſs muſt be ſtill more hot and viſcid; the head Blood-Globules being depriv'd of their diluting Serum, will be excited into the moſt violent inteſtine Motion; and this Tumult and Efferveſcence of the heated viſcid *Craſſamentum*, acting as a *Stimulus* upon the muſcular Coats and Fibres of the Blood-Veſſels, will excite the nervous Syſtem into ſuch ſtrong and violent Efforts, in order to carry on the Circulation, and remove the growing Weight and Reſiſtance of the turgid riſing Blood.

But the Serum ſtill diminiſhing, and the Heat, Effervescence, and inteſtine Motion of the *Craſſamentum* increaſing, Nature will ſoon be brought to her laſt Struggles in continual Watchings, Deliria, Ravings, purple, black, and livid Spots upon the Surface of the Skin; bloody Secretions, Gangreens and Mortifications of the glandulous and muſcular Fleſh; a trembling intermitting Pulſe; an hot ſuffocating Breath, *Deliquia*, ſoporiferous Stupors, convulſive Sighs, with other ſuch-like diſmal Harbingers of a general Wreck, which come to give the By-ſtanders notice of approaching Death.

Now to prevent this Tragedy, as ſoon as a Fever commences, and threatens an Inflammation, Nature takes care to ſhut up all the Sluices and Outlets of the Serum, that as much as poſſible of the thin and aqueous Parts of the Blood may be retain'd, to diſſolve and dilute the *Craſſamentum*, till the Quantity of the Serum be increas'd, ſo as to be capable by its natural Weight and Impetus to make its way again into the obſtructed Lymphaticks; which being done, and the Blood thereby ſufficiently condenſed, cool'd and diluted, the excretory Ducts and Orifices of the expurgatory Glands are by the Action of Nature open'd again, in order to let out the morbid Serum which has been accumulating, corrupting, and putrefying in the Lymphaticks, during the Riſe and Progreſs of the Fever.

The

THE manifeſt Diminution of all the Evacuations, or expurgatory Secretions in a true and regular Fever; the Care of Nature in ſhutting up the ſmall Pipes and Paſſages of the firſt Urines, that a greater Quantity and Proportion of what is drank may paſs into the Blood; the plain Voice and Law of Nature expreſs'd in the painful Senſation or *Stimulus* of Thirſt, and commanding a free and plentiful uſe of thin diluting Liquors; and eſpecially the many dangerous Conſequences which are always found by Experience to follow from any large ſymptomatical Evacuations in a Fever, where the Serum is thrown off in Sweats or Stools before it had done its proper work, by preparing the Blood for a due Criſis, or a regular Solution of a Fever: All theſe Facts put together, I think, afford us a ſufficiently clear and full Proof of the truth of this Theory, concerning the natural Production, Conſtitution, and Solution of a Fever.

COROLLARY.

FROM what is here ſaid it is manifeſt, that there are three very different and remarkable States and Periods to be obſerv'd and diſtinguiſh'd in every Fever: The firſt is the State or Period of its ariſing or generation, while the Heat and Rarefaction of the Blood is ſtill increaſing, and the Influx of the Serum thro the Lymphaticks more and more obſtructed and diminiſh'd.

THE ſecond is its conſtituent, fix'd and ſtanding State, or that Period in which the Fever having obtain'd its full Growth and perfect Formation, retains its whole Form and Conſtitution for a time, while Nature is employ'd about the moſt nice and difficult Work, in order to bring about a ſalutary Criſis.

THE third and laſt State of a Fever is the Criſis, or that Period in which the Blood condenſes, dilutes and cools; and the Serum taking its due Courſe again thro the Lymphaticks, the ſtagnated, corrupt, and putrid Lymph or Serum is waſh'd off, and thrown out in the critical Diſcharges of Sweat, Urine, Stools, *&c.* But if Nature cannot bring about a ſalutary Criſis, and be not aſſiſted by Art, this Period puts an end to the Diſeaſe and Life together.

COROLLARY II.

FROM hence it evidently follows, that the moſt proper and ſeaſonable time for the aſſiſting of Nature, and in which the Advice of a Phyſician who underſtands his Buſineſs will be of the greateſt Conſequence, is the firſt ariſing or generating State of a Fever.

SUCH is the inimitable Wiſdom and Contrivance diſcover'd in the Structure and Conſtitution of an animal Machine, that more Fevers are prevented and reſtrain'd by the Care and Providence of *Nature*, than are ever cur'd by the *Phyſicians*. And indeed, where Nature

Nature obtains her first Intention, which is to throw off the generating Principles and original Stamina of the Disease, there is no need of the Assistance of Art afterwards. And since *Nature* is the original Standard and Archetype of *Art*, there is no need of any thing else for the Information and Instruction of a good Physician how to proceed in this Case, but only to observe the measures of Nature, and how she obtains her end where she is not some way or other prevented, hinder'd, or obstructed in her Work.

Now to apply this: 'tis evident from what has been already observ'd concerning the Production and Formation of a Fever, that the first Principles and original Stamina of the Disease are laid upon the Stomach or Intestines; where a hot inflammatory Flatus being excited, the Business of Digestion is interrupted and perverted, and the due Separation of the grosser from the more fluid Parts of the Chyle prevented.

Now in this Case the Business of Nature, or which is the same thing, the natural Consequence of such a State and Disposition, is,

1. THAT the muscular Coats, or nervous Fibres of the Stomach and Intestines, being urg'd by the Irritation and *Stimulus* of such heated, indigested, viscid, and rarefy'd Matter, are hereby brought into violent Action, or excited to very frequent and strong Contractions; by which means the indigested morbid Matter lodg'd in the first Passages, is thrown

out of the Body by a natural Vomiting or Purging, or both, according to the present State and Disposition of Nature.

2. During the *Luctus* and Struggle in the Stomach and Intestines, the Person by a certain loathing and reluctancy against solid Food, and all such Meats as require a considerable Time and Apparatus for Digestion, is forbid the use of them by the Voice and Law of Nature: for 'tis plain that while this great Gland, *i. e.* the Stomach, with its digestive Organs, and its excretory and secretory Ducts, the Intestines and Lacteals, are thus indispos'd, nothing that requires much digestion can be taken in without detriment; since all such things in this Case must necessarily increase and heap up that Load of flatulent, viscid and indigested Matter, which Nature is now labouring to cast off. And in this primary Intention of preventing the first perfect Formation and Fixation of the Disease, the Circumspection and Diligence of Nature seldom fail her, unless the Weight and Resistance be too great at first, or she be otherwise injudiciously hinder'd and obstructed in her Work.

3. And because while this is doing it must needs happen, that some Part of the heated viscid Chyle must have made its way from the Stomach towards the Blood, so as to begin the Obstruction in the chyliferous Ducts and the lymphatick Canals of the conservatory Glands; therefore Nature takes care, by

the *Stimulus* of an uneasy Dryness and Thirst, which is the natural Consequence of Heat and Rarefaction; I say, Nature hereby takes care to command a timely abstinence from all heating fermenting Liquors, and instead of these to drink freely of such Liquors as are cooling, attenuating and diluting, without Fermentation. And by this means the chyliferous Ducts are wash'd and cleans'd, the Heat, Viscidity and Rarefaction in the first Passages suppress'd, the Digestion restor'd, and a free Passage made for the usual Drain and Circulation of the Lymph from the Arterys to the Veins.

And thus the first Intention of Nature is obtain'd, a Crisis brought about, and the Solution of the Fever procur'd in the most safe and effectual way, before the Disease comes to be perfectly form'd, and fix'd on the whole animal System.

Having thus given the curative Intentions, and Method of Nature in this first Period of a Fever, I presume those who have a Genius for Medicine, and any acquaintance with it, will easily excuse me from being more particular. And indeed, he who cannot collect from this Corollary what ought to be done when occasion offers for the assisting of Nature in this Case, is not fit to be a Physician, and would not be much the better, in all probability, for a larger Discourse about it.

COROL-

COROLLARY III.

FROM the foregoing account of the Production and Formation of Fevers, it may be obſerv'd of what miſchievous Conſequence it muſt be in the full growth and perfect Formation of a Fever, to precipitate the Criſis or Solution by unſeaſonable injudicious Evacuations.

IF the perfect Formation of a Fever cannot be prevented, and the firſt Intention of Nature obtain'd, according to the laſt *Corollary*, but the Diſeaſe comes to form and fix it ſelf upon the whole Animal Oeconomy, it will then have a certain ſtationary Period natural and peculiar to it: And this ſtationary Period is either employ'd by Nature, or ought to be employ'd by Art, in preparing and diſpoſing the Blood and Humours for a regular Criſis.

IN this caſe Nature her ſelf, if too haſty, ought to be reſtrain'd, as every Phyſician muſt be ſenſible, as often as he meets with any large ſymptomatical Evacuations, which are always attended with the worſt Conſequences, if not ſeaſonably and judiciouſly prevented. And if this be conſtantly ſo, as all Experience teſtifys where the ante-critical Evacuations happen in a natural way, what can be ſaid for the Practice of thoſe, who as ſoon as ever they are ſent for, without conſidering the Nature and State of the Fever, fall immediately to work by ſtrong Eme-

Emeticks, Catharticks and Sudorificks, to force off large Quantitys of the Serum or thinner Parts of the Blood, while they ſhould rather endeavour to increaſe it, and lay up as much as poſſible in ſtore for a ſeaſonable, natural, and ſalutary Criſis?

When a Fever is once thorowly form'd, the urging it to a Criſis before its natural time is procuring an Abortion, which in this Caſe is always dangerous, and for the moſt part mortal. And the Reaſon of this is evident; for ſince in this ſtate of the Diſeaſe, where the Fever has fix'd it ſelf upon the whole Maſs of Blood, the heated, rarefy'd, viſcid Serum is ſo cloſely united and intimately mix'd with the *Craſſamentum*, that it cannot be ſeparated without great Violence: and ſince in conſequence of this, the communication of the Serum from the Arterys to the Veins thro the Lymphaticks, muſt be in a manner intercepted and cut off, 'tis manifeſt that the forcing away the Serum thro the expurgatory Glands, while the Blood is in this ſtate, muſt leave the remaining Part of the Maſs ſtill more hot and viſcid, prevent a ſupply of cool diluting Serum from the Lymphaticks, and render the Canals impaſſable, and diſpoſe the Glands to a Mortification, or Gangreen. In ſhort, ſuch a Proceeding cannot but be of very ill conſequence, even tho Nature, as it ſometimes falls out, ſhould chance to be too ſtrong both for the Diſeaſe and the Phyſician together. For hereby all the

the Symptoms will be aggravated, new ones induc'd, the Diſtemper protracted, and at laſt a very imperfect Criſis procur'd, which perhaps converts the Fever into ſome more chronick Diſeaſe; ſuch as a Scurvy of the worſt kind, a *Phthiſis*, Dropſy, calculous Secretions and Petrifications, *&c.* by which the Patient is retriev'd only for a longer ſcene of Miſery, and the Caſe render'd more lingring, but not leſs dangerous. During this Period of the Diſeaſe, the Phyſician therefore is to attend with Patience, and carefully wait the farther Orders and Directions of Nature.

HOWEVER, in the mean while the Buſineſs of Dilution muſt be carefully and diligently manag'd; for this is the proper time to cool and attenuate the viſcid Humours, and to reſtrain and ſuppreſs the Rarefaction of the Blood: And this will be beſt done by convenient Drinks and in ſufficient Quantitys, aſſiſted with the *Teſtacea*, Sal Prunel, vegetable and mineral Acids; ſuch as Juice of Lemons, Spirit of Sulphur, Spirit and Oil of Vitriol, *&c.* in Drinks and Juleps: ſtill regarding with great Care and Attention the Habit, Cuſtom, and Conſtitution of the Patient in his Health, as well as the preſent State and Symptoms of the Diſeaſe, to know what degrees of Cooling and Dilution may be moſt proper, and when and how far to moderate and reſtrain it.

By this Method a natural and regular Crisis may in due time be expected: The Serum of the Blood, which during the constituent State of the Fever had been over-heated, and closely and intimately mix'd with the *Crassamentum*, now comes to condense, separate, and pass off as usual by the several Secretions, both of the conservatory and expurgatory Glands; which is, I think, what ought strictly and properly to be call'd the Crisis or Solution of a Fever. Now of this Crisis or Solution, the Signs, Symptoms or sensible Appearances, are some or all of those which follow.

I. A SENSIBLE abatement of the Heat or Thirst, with a beginning Moistness and Lubrication of the salival Glands.

II. A PALER colour'd and a somewhat thick or muddy Urine, with a Sediment or Separation of its Parts upon standing.

III. AN easy, cooling, periodical *Diaphoresis*, or Sweat, which is at the same time pretty sensibly salt, viscid and fetid.

IV. VISCOUS, tenacious and black, or otherwise discolour'd stinking Stools.

V. DISTINCT periodical Intermissions or Remissions, where the Fever was before continual, or with very irregular, imperfect, indistinct Intervals.

VI. A PRETTY equal, regular and natural Pulse, especially during the critical Discharges.

As ſoon as the Criſis or Solution of the Fever manifeſtly appears by theſe Symptoms, eſpecially when the Intermiſſion or Remiſſion comes to be diſtinct, periodical and of any continuance, the Phyſician is preſently and without loſs of time to betake himſelf to that great and noble Antifebrifick, the Peruvian Bark, as the ſureſt and moſt ſacred Aſylum in this Period of the Diſeaſe, and what may moſt rationally be depended on to ſecure a regular and ſalutary Criſis.

And this incomparable and divine Medicament may be ſo judiciouſly compounded and mix'd up into Juleps, Electuarys, Boles or Pouders, as to render it Solutive, Diaphoretick, or Diuretick, according to the principal critical Indication, or the particular Secretions or Paſſages by which Nature ſeems moſt diſpos'd to throw off the morbid Matter.

And here, ſince it may perhaps be of ſome uſe to younger and leſs experienc'd Phyſicians, I will ſet down my own Method of giving the Bark in Fevers.

In the Intermiſſion or Remiſſion, when the foregoing Signs of Concoction or Solution appear, I order the following Pouder to be taken every three Hours, or at any time between the Fits, as the Intervals will permit, where there is not time for ſeveral Doſes between any two ſucceſſive Fits.

℞ *Cortic. Peruvian.* ℥ ſs.
Coccineal. Rhabar. ā ℥ i. *Miſce. f. pulv. Divide in Chartulas*, N° 12.

If

If this, as it ſometimes happens, ſhould have too great a Diſpoſition to paſs off downwards before it can make its due Impreſſion upon the Blood and Humours, it may be conveniently alter'd thus:

℞ *Cortic. Peruvian.* ℥ ſs.
Rad. Serpent. Virginian. ʒ 2. *Miſce.*
Divide in Chartulas, N° 12. *ut prius.*

But indeed ſometimes the Bark it ſelf will purge, and paſs off too faſt, as being too great a *Stimulus* and Aſtringent for ſome very weakand tender Conſtitutions; and in this Caſe it will be moſt conveniently given in an Electuary with Diaſcordium, or the *Theriaca Andromachi*, after the following manner.

℞ *Theriac. Androm. Diaſc.* $\overline{aa}$ ʒ 2 ſs.
Cortic. Peruvian. ℥ ſs.
Rad. Tormentil. ʒ 2. *Miſce.*
& cum Syr. Cydon. q. ſ. fiat Electuar.
ſumat Q. N. M. *tertia quaq; horâ.*

When I find the Intermiſſions perfect, or the Remiſſions long and diſtinct, ſo as to diſcover the laſt evaneſcent State of the Fever, that I may cleanſe and open all the Glands in general, eſpecially thoſe of the Kidneys, and ſecure a perfect Criſis, I give the Bark with the Æthiops Mineral, or Cinnabar of Antimony, or rather both together, thus:

℞ *Cor-*

℞ *Cortic. Peruvian.* ʒ ʒ.
Æthiop. Min. Cinnab. Ant. ā ā ʒ ß.
Rhabar. ʒ ı. *Miſce. f. pulv.*
Divide in Chartulas, N° 12. *ſumat ter quaterve in die.*

Or, if the form of an Electuary pleaſes better, it may be thus directed:

℞ *Conſerv. Abſinth. Roman.* ℥ ı.
Cinnab. Ant. Æthiop. Min. ā ā ʒ ß.
Cortic. Peruvian. ʒ ʒ. *Miſce.*
& cum Syr. è Chalyb. q. ſ. fiat Electuar. craſſioris conſiſtentiæ, ſumat Q. N. M. *ter quaterve die, ut prius.*

While theſe are in uſe, if need be, a Purge or two may be given, and then the Perſon adviſ'd to take the free and open Air, and to ſet himſelf on ſome eaſy moderate Exerciſe.

COROLLARY IV.

From this general Theory 'tis evident, that all Fevers are in ſome degree or other putrid; and that every true and natural Criſis, is a diſcharge and expulſion of that putrid or corrupt, ſtagnate and morbifick Matter.

For ſince in every Fever (as has been prov'd from the Nature and eſſential Characteriſticks of Fevers in general) the Separation of the Lymph or Serum from the Blood, both by the conſervatory and expurgatory

gatory Glands, is in some measure intercepted, suspended and obstructed, during the Heat, Rarefaction and Viscidity of the Blood, and the strong Cohesion of the Serum with the *Crassamentum:* and since the Serum or Lymph both in the conservatory and expurgatory Canals must needs corrupt, putrefy, and contract a preternatural *Stimulus* and Acrimony, in proportion to the Diminution of its Motion and beginning Stagnation; and likewise in consequence of the Heat and Impetus of the distended turgid Blood-Vessels, with which the Lymphaticks or excretory Canals and Emunctorys of the Serum are compress'd and constipated in a Fever: 'tis manifest from hence, that a Putrefaction, Corruption, or preternatural Acrimony of the Serum in its proper Canals, must begin and proceed with the Fever, and will be proportional to the Nature and Quantity of the Obstruction.

'Tis true indeed that in Ephemeras and Intermittents, where there is an entire Solution of the Fit after a short Period, this *Fœtor*, Putrefaction, and Acrimony of the Sweats and critical Discharges, are not so apparent and sensible, as where the obstructed Matter is longer detain'd in greater Quantitys, and wrought up to a more intense Solution and Corruption: tho still the same Qualitys may be observ'd in a lower degree, proportional to the Strength and Duration of the Fever, and the Quantity of the Obstruction.

And from hence it plainly appears to be a great miſtake in thoſe who derive this morbid Matter immediately from the Blood, at the very time of the Criſis; and ſuppoſe that the Blood during the ſtate of the Fever has been fermenting like ſome ſpirituous Liquor, in order to throw off at laſt theſe putrid, corrupt, and acrimonious Recrements. But the Conſequence of this Miſtake is often fatal, when upon the Credit of ſuch an Hypotheſis, the Blood, even in the height and rage of Fevers, is ſtill more heated and inflam'd with warm active Cordials, Alexipharmicks, inflammable Spirits, volatile Salts, and the like, under a pretence of fortifying the Heart, ſtrengthning the Spirits, expelling Poiſon, and driving away Malignity.

This is blowing up the Diſeaſe, and putting Nature to the fiery Trial; a ſhort and ſure way indeed to come to ſome end or other of the Matter, but a Method which the beſt practical Phyſicians, after the too great Coſt of Experience, have now thrown up, tho many of them ſtill retain the falſe Hypotheſis upon which it was grounded.

SCHOLIUM I.

I am ſenſible, upon ſuch a Subject as this, how difficult 'tis to ſpeak unexceptionably; and therefore it may be proper, before I proceed farther, to obviate ſome Objections which may poſſibly be made againſt ſome part of what has been here advanc'd; eſpecially

cially as to what has been offer'd under the third *Corollary* of this Propoſition, againſt large Evacuations or Drains of Serum from the Blood, during the height and ſtationary Period of Fevers.

And here it will perhaps be urg'd, that this is contrary to the approv'd eſtabliſh'd Practice of very good and well-experienc'd Phyſicians, who in the ſtrength and full growth of Fevers, very often draw off and cauſe a conſiderable Evacuation of the Serum, both by Bliſtering and Sudorificks as well as Catharticks.

Now I own that every one may have obſerv'd this practice in Phyſicians, and I readily grant alſo that 'tis very often attended with Succeſs, and that there may be a plain Reaſon and indiſpenſable Neceſſity for it, under a judicious Management: but then I deny that the real Deſign or true Intention in this Caſe is to draw off the Serum from the Maſs of Blood, or to leſſen its Quantity in general, which is the thing ſuppos'd in this Objection, for elſe it can be levell'd againſt nothing I have advanc'd. And that the true Intention of Bliſters, Alexipharmicks and Sudorificks, when given or apply'd in this ſtate of Fevers, is not to draw off the Serum from the Blood, or to leſſen the Quantity of Serum in the Maſs of Blood, is evident from hence; That the ſame Phyſicians at the ſame time, if they act rationally and know what they are doing, are al-

ways careful to enjoin free and plentiful drinking of such Liquors as are cooling, diluting, and without a Ferment; such as may most easily and speedily pass, and make their way to the Blood. This is of such consequence in the Cure of Fevers, especially when they are come to their full Growth and Maturity, to prepare them for a good Crisis, that any other Method without it can be of little use.

Now this free and plentiful drinking and diluting, which all Experience testifys to be of the greatest Consequence in Fevers, is manifestly the nearest and most effectual way to increase the Serum of the Blood, or to augment its Quantity in proportion to the *Crassamentum:* and this is beyond all dispute the true Design of it; the Reason and Necessity of which we have seen already.

But this increasing the Serum in Quantity, and cooling it in Quality, by Drinking or Dilution, must, according to the nature and import of this Objection, be contrary to the Physician's Intention, while he is lessening its Quantity, and heating it at the same time by the Force and *Stimulus* of Blisters, Alexipharmicks, and Sudorificks. But it cannot be imagin'd that any Man in his Wits, and much less a skilful Physician, should aim at such an Impossibility as heating and cooling, lessening and increasing the Serum at the same time: and therefore it may be of some Consequence here to shew the true Intention of this hot Method in Fevers, where it is judi-

ciouſly us'd, and ſo as to obtain any real Advantage from it.

I. 'Tis well known, that very often in Fevers the principal Inflammation falls upon a particular Part; in which Caſe the Lymphaticks and glandular Canals belonging to the Part affected, being diſtended with a hot, viſcid, acrid Serum, which cannot paſs off by its uſual Drains, the muſcular Coats and nervous Filaments of the affected Parts will be heated, ſtimulated, and put into violent Action; and in conſequence of this, a greater Quantity than ordinary of the Blood will be urg'd and deriv'd to the Part, which not being capable of paſſing off in the Courſe of its Circulation as faſt as it is deriv'd, it muſt needs dilate and diſtend the Blood-Veſſels; and being thus buoy'd up and pent back upon a particular Part, it muſt be put into a violent Fluctuation and inteſtine Motion, and become more hot and turgid: *i. e.* the Part thus affected will be tumefy'd and inflam'd. And this Inflammation of the Part will diſcover it ſelf by the Senſe of Weight and Oppreſſion, attended with hot and burning, or with ſharp, pungent, and acute Pains.

Now when this happens to be the Caſe with reſpect to the Lungs, the Bronchia, the Pleura, the Tonſils, the Brain with its Meninges, or any particular Part from which a convenient Derivation or Drain may be directly made by Epiſpaſticks or Veſicatorys; Bliſtering in all ſuch Caſes will be of the

greateſt conſequence, and ſoon diſcovers its good Effects, as all Experience teſtifys. For by this means the heated, ſtagnate, corrupt, and acrid Serum being drawn off, and the *Stimulus* and Irritation upon the nervous Coats and muſcular Fibres remov'd, the Blood will have time to cool, condenſe, and take its uſual Courſe; which will ſoon diſpoſe the Fever to a natural and good Criſis or Solution.

But beſides this more apparent and ſenſible Effect of theſe Veſicatories juſt now taken notice of, there is another Conſequence of the ſame Method, which muſt be equally beneficial in the Caſe before us, tho it is not ſo commonly obſerv'd, and it is this; That from the Heat and Rarefaction rais'd on the Surface by the potential Cauſtick or Epiſpaſtick, there muſt be a conſiderable drain of the heated, rarefy'd, expanded Air contain'd in the Blood, and impriſon'd or ſhut up in the internal, tumefy'd, inflam'd Part; which being the chief Cauſe of the Inflammation and Tumefaction, whilſt retain'd in the viſcid tenacious Blood or Serum, its being diſcharg'd muſt neceſſarily abate and take off the Heat and Intumeſcence. For the clearer underſtanding of which it muſt be obſerv'd,

1. That, as has been prov'd already, the Pores, and Interſtices of the Blood and animal Liquors, as well as all other Fluids, are fill'd and repleniſh'd with elementary Fire and Air; which, by their conjunct and mutual

tual Action upon each other, are the Cauſes of all Heat, inteſtine Motion, Tumeſcence, and Rarefaction in Bodys.

2. WHEN any glandulous and muſcular Part or complicated Organ ſhall be irritated or ſtimulated in the manner before deſcrib'd, and the Blood thereby deriv'd into it in too large Quantitys, ſo as to diſtend, tumefy, and inflame the Part, 'tis manifeſt that an Obſtruction muſt hence enſue; ſince in this Caſe, only the thinner Parts of the Blood can be carry'd forward thro the capillary Arterys into the Veins, while the thicker, more viſcid, and tenacious Parts will be retain'd and accumulated, as being leſs capable of Motion. And the elaſtick Air being retain'd in great Quantitys by this thick viſcid Blood; and being hereby heated, rarefy'd, and put into a violent Commotion, while it cannot diſengage it ſelf from the tenacious Blood, it will be the chief Cauſe and Inſtrument of the Tumefaction and Inflammation.

3. 'TIS evident in Fact, that the Surface of the Body is every where provided with abſorbent Veſſels, by which any external Applications to the Skin, provided they are ſubtile, thin, and fluid enough, are receiv'd and carry'd into the Blood; and which are of the ſame nature with the Lacteals and abſorbent Veſſels in the Stomach and Inteſtines. This is plain in Fact, from the Application of Plaiſters, Ointments and Waſhes; the Matter of which has a free and eaſy Paſſage into the

Blood, as the Effects teſtify: And 'tis impoſſible they ſhould paſs to the Blood thro the excretory Ducts of the cutaneous Glands, without ſuppoſing two contrary Motions in thoſe Canals at the ſame time. And therefore the Exiſtence of theſe cutaneous abſorbent Veſſels, every where on the Surface, cannot be doubted of.

4. The very active, ſubtile and pungent Salts therefore, with which the Cantharides in Epiſpaſticks and Veſicatories abound, having a free and eaſy Paſſage to the Blood, muſt upon the proper Application of a Veſicatory, ſoon make their way and mix themſelves with the viſcid, thick, tenacious Blood, in the obſtructed inflam'd Gland, Muſcle, or other complicated Organ, which is ſuppos'd to lie directly under the Epiſpaſtick. And theſe Salts, by their ſubtilty and activity, muſt break, divide, and attenuate the viſcid cohering Parts of the Blood, and thereby make way for the retain'd impriſon'd Air to eſcape and fly off: eſpecially when at the ſame time there is a way made for its Exit, by the Heat and Rarefaction on the Surface; and conſequently the elaſtick Flatus muſt be impell'd thither, and paſs off by the Veſicatory, where it finds the leaſt Reſiſtance.

Now from all this it is manifeſt, that the true Intention of Bliſtering in ſuch Caſes, is not to drain off the Serum from the Maſs of Blood in general, or to leſſen the Quantity of Serum in general, and upon the whole; but

but only to derive and draw it off from ſome particular Part or principal Organ; where, by its too great Quantity and vicious Quality, it irritated and diſorder'd the Parts, and occaſion'd an Obſtruction and Inflammation. But,

II. THERE is another general Caſe, in which Bliſters well manag'd may be, and very often are of great ſervice; and that is in ſuch Fevers as are commonly call'd Inward, Depreſſing, and Nervous.

THE common Symptoms of theſe Fevers are, a great Weight and Oppreſſion in the Stomach and Abdomen; an inward, central, parching Heat; Cholick Pains, melting, burning, painful Diarrhæas; very high-colour'd, and ſometimes bloody Urine; a weak, low, but quick, irregular and trembling Pulſe; great Laſſitude and Weakneſs; cold Sweats, Faintings and Convulſions; with comatoſe Stupors, and a liſtleſs diſregard of any thing that is ſaid or done, from forgetfulneſs or loſs of Memory.

NOW from all theſe Symptoms, 'tis manifeſt that in ſuch ſort of Fevers, the Blood by ſome preternatural *Stimulus* is deriv'd in too great a Quantity and *Momentum* inwards upon the Stomach and Viſcera; and thrown with an unuſual Impetus upon the ſeveral Bowels and Organs contain'd in the Abdomen; while the Head, the Breaſt, and all the Parts ſupply'd from the aſcending Trunk of the *Aorta*, are depriv'd of their

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due ſhare and proportion of the vital Fluid: whence proceed the comatoſe Stupor, the ſmall low Pulſe, the external Cold, and all the reſt of the Symptoms.

Now in ſuch central or refluent Fevers, as I chuſe to call them, from that particular Determination of the Blood which is the Cauſe of them; Veſicatories apply'd to the Head, Neck, Arms, *&c.* are often of great uſe to draw out the Fever, raiſe and diffuſe the natural Heat, derive the Blood upwards, and outwards; and thereby prevent the moſt fatal and dreaded Conſequence which may otherwiſe be expected in ſuch Caſes; that is, a Mortification of the Viſcera. And for the ſame Reaſons that Bliſtering is uſeful under this Claſs of Fevers, moderately warm Cordials, Alexipharmicks, and Sudorificks may be likewiſe profitable, to derive the Heat outwards, and prevent a too great Surcharge of Blood and Humours upon the Stomach and Viſcera; eſpecially in a threatning ſymptomatical Diarrhæa, which it may be often neceſſary to check and reſtrain; and which Experience aſſures us may be beſt done by raiſing a gentle breathing Sweat.

But he, who obſerving the uſe that good Phyſicians ſometimes make of theſe heaters in Fevers, concludes from hence, that the Deſign of it is to force off the morbid Serum of the Blood, as if a Criſis might be procur'd or attempted at any time, is extremely miſtaken: and whoever ſhould pro-

ceed upon such a Supposition, would certainly do it very much to the Cost and Detriment of those who should be so unhappy as to fall under his Management.

In the several Instances hitherto given of Evacuations artificially procur'd, before the Crisis or Solution of the Fever is expected, I suppose it must be evident, that the true Design of it is only to make such a Derivation or Revulsion of the Blood and Humours, as Nature shall indicate to prevent some worse Consequence: and indeed, all these Evacuations, which are sometimes artificially procur'd before the natural Crisis, are not made for the sake of the Evacuation it self, as properly critical; as if the time of the Crisis was in the Physician's hands; but only to prevent some greater and more dangerous, symptomatical, and preternatural Discharge or Evacuation, which must otherwise have happen'd.

But after all, notwithstanding the prudential use of Vesicatories, hot Alexipharmicks and Sudorificks, in the Cases and for the Purposes hitherto recited, yet in Fevers of another kind, which are commonly call'd Inflammatory; such as are attended with a high, strong, turbulent Pulse; great Strength, delirious Outrage; a burning external Heat, and especially where the Appearance of *Purples* on the Surface of the Skin, which are a sort of bloody Secretions, discover this diffus'd external Heat to be universal: in these Cases, I say,

I ſay, and under ſuch Symptoms, nothing can be more abſurd or pernicious, than the Application of Bliſters, or the Uſe of any heating, rarefying, attenuating Medicines. Nature it ſelf will abhor any ſuch Method; and the fatal Conſequences of it when raſhly ventur'd on, will ſoon diſcover the Error, and proclaim aloud the Madneſs of the Phyſician.

SCHOLIUM II.

It may be urg'd farther, that ſince a Plethora, or preternatural Fulneſs and Diſtenſion of the Blood-Veſſels, muſt needs be the Conſequence of a Diminution of the Secretions, and the increaſed Heat and Rarefaction of the Blood in Fevers; therefore Evacuations muſt be proper, and neceſſary at any time, in order to take off the Plethora, which is a main Symptom and principal Part of the Diſeaſe.

But it ought to be obſerv'd here in the firſt Place, that a Fever is not always attended with a Plethora, either as to its antecedent Occaſions or conſequent Effect: for it is well known that Fevers make their Onſets upon ſome too great and preternatural Evacuation, by which the Quantity of the circulating Fluid has been very much diminiſh'd; ſuch as profuſe Sweats, Diarrhæas, *&c.* And at the ſame time ſome ſymptomatical Secretion, or Diſcharge, may ariſe and proceed with the Fever; by which Diminution of the refluent Maſs in Quantity, the Fever is ſo far from being

being leſſen'd or abated, that 'tis viſibly increas'd and ſtrengthen'd; as all Experience teſtifys, and every one in Practice muſt be ſenſible of.

And as this proves that there may be a Fever without a Plethora in Quantity; ſo 'tis likewiſe evident from hence, that where the Plethora really exiſts, and is ever ſo evident in Fact, we are not preſently and at any time to attempt the leſſening it by Evacuation, ſince we are ſo often oblig'd to check or reſtrain the precipitation and over-haſte of Nature in this Caſe, when any Secretions are unſeaſonably forc'd off, before the natural time of the Criſis; and which Secretions are well known to the Phyſicians under the Name of *Symptomatical*, which are always reckon'd as a Part of the complicated Diſeaſe.

But the principal thing I would obſerve here, is, that the Plethora of the Blood-Veſſels, occaſion'd partly by the increaſed Quantity, and partly by the Heat and Rarefaction of the Maſs; I ſay, this Plethora, which is indeed the general and moſt natural Conſequence of a Fever, is likewiſe neceſſary to the Cure; as being a wiſe Proviſion made by Nature, to enable her to bear the expence of the approaching Criſis. For the Quantity of the corrupt putrefy'd Serum, which had been lodg'd in the Lymphaticks and glandular Canals during the Fever, and which muſt be waſh'd out and thrown off in the Solution of

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the Fever, when the Blood comes to cool and condenſe, is oftentimes ſo very great, and the neceſſary ſupply of new Lymph from the Blood, at that time ſo conſiderable, that if there had not been a Plethora before in the Blood-Veſſels, the Criſis muſt be inevitably mortal.

But for the clearer and more ſatisfying account of this, I ſhall here reduce it to a *Calculus*, ſuch as the nature of the Thing is capable of.

It appears then, from the Obſervations and Experiments which the learned and induſtrious Dr. *James Keil* has given us in his *Tentamina Medico-Phyſica*, that the Proportion of Fluids in an animal Body, is to that of the Solids, at leaſt as 5 to 3; and conſequently that in a Body weighing 160 Pounds, 100 Pounds of that Weight will be made up of Fluids. Now I ſhall ſuppoſe that a fourth part of this Fluid is contain'd in the Bones, Nerves, Cartilages, and ſolid Ligaments; which I preſume muſt be allow'd as a ſufficient Proportion, and of which, perhaps, there may be no great waſte or diminution in a Fever. And this $\frac{1}{4}$ of the whole, or 25 Pounds, being ſubtracted, there will remain 75 Pounds of the Fluid for the Blood-Veſſels, Lymphaticks, and glandular Canals.

The Proportion of the Lymphaticks and glandular Canals to that of the Blood-Veſſels cannot eaſily be determin'd, and therefore an exact Computation cannot be here expected; but

but thus much is certain, that the Lymphaticks and draining Canals of the Serum, tho ſmall, are yet exceeding numerous, and make up a very conſiderable part of the glandulous and muſcular Fleſh. This is manifeſt from the great Quantity of Serum, continually ſeparated from the Blood, and thrown off by the ſeveral excretory Ducts of the Body; and which is not ordinarily leſs than five Pints or Pounds, in the ſpace of 24 Hours: and likewiſe from the ſtill greater Quantitys of the Lymph or Serum continually drawn off and pour'd into the Blood again, to anſwer the Purpoſes of Attenuation, Comminution, Cooling and Dilution. I ſhall here ſuppoſe therefore, that the Quantity of Blood, or of the mix'd Maſs contain'd in the Arterys and Veins, is to the Quantity of Lymph or Serum contain'd in the ſeveral *Tubuli* or *Receptacula* of the Glands, as 4 to 1: And conſequently that where the Blood or mix'd Maſs contain'd in the one, amounts to 60 Pounds, the Lymph or drain'd Serum contain'd in the other, will be 15 Pounds. Now 'tis evident that during the Flatus and Inflammation of the Fever, the greateſt Heat and Rarefaction muſt be in the Blood, or mix'd Maſs; eſpecially in the Arterys, where the Fluid has the greateſt Velocity and Impetus. And from this Rarefaction and Repletion, dilating and diſtending the Blood-Veſſels, 'tis plain that the Lymphaticks and draining Canals muſt be every where compreſs'd or conſtrain'd; by which

which means the moſt fluid and ſubtile Parts of the Lymph and Serum, and ſuch as are moſt capable of Motion, will be preſs'd and ſqueez'd out and carry'd off, either by ſome ſymptomatical Evacuations where theſe happen, or elſe by inſenſible Perſpirations, during the Heat, *Luctus*, and Commotion of a Fever.

Now if from the Conſtriction of the Lymphaticks, a third part of the Lymph or Serum contain'd in theſe conſtipated Canals be ſuppos'd to be forc'd out and carry'd off, *i. e.* 5 Pounds where the whole Quantity is 15 Pounds; 'tis plain that at the Criſis, when the Blood comes to cool and condenſe, the Blood-Veſſels to contract, and the Lymphaticks to enlarge and diſtend as before, the drain'd Serum taking its uſual Courſe, will paſs thro the Glands into the Lymphaticks and ſecretory Canals, now at liberty to receive it, in order to ſupply what had been forc'd out and carry'd off during their ſtate of Conſtipation and Contraction: which will be the ſame thing in effect as if the diſtended Blood-Veſſels and conſtring'd Lymphaticks remaining *in ſtatu quo*, 5 Pounds of Blood had been taken off at once, or in a very ſhort time. And as a conſiderable Depletion of the Blood-Veſſels muſt enſue upon the Criſis, or Solution of a Fever from the Cauſe juſt now mention'd, it may be obſerv'd farther, that the corrupt Lymph or ſerous Recrements, which during the Fever had been detain'd, and pent

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up in thoſe compreſs'd conſtipated Canals, being now waſh'd out by a freſh and free ſupply of new-drawn Serum from the Blood; and being unfit to be retain'd in the Maſs, and uncapable of ſubſerving the ſeveral Offices and Functions of Life, muſt therefore be thrown off thro the proper excretory Ducts and Outlets of the Body, in critical Diſcharges, during the time of the Criſis; and theſe critical Evacuations being made in a greater Quantity and Proportion than can poſſibly be ſupply'd again in the ſame time, muſt ſtill more and more empty the Blood-Veſſels, and occaſion a greater Depletion.

But beſides the two laſt mention'd, there is another Cauſe of Depletion, upon the Criſis or Solution of a Fever; and that is, from the Condenſation of the Blood, which having been very much heated and rarefy'd during the Flatus and Fluctuation of the Fever, when that Heat and Rarefaction ceaſes, as in the Criſis, the Blood will recover its former cloſer Texture and Coheſion of Parts; by which means the ſame Quantity will be contain'd in a leſs Space. And this will be the ſame thing in effect, as if the Rarefaction and ſpecifick Gravity remaining as before, a certain Quantity of the Fluid had been taken off; ſuch as is proportional to the previous febrifick Fermentation, and the conſequent critical Condenſation.

THESE neceſſary and natural Cauſes of Evacuation and Depletion upon the Criſis of a Fever, may, I ſuppoſe, be ſufficient to ſhew that the antecedent febrifick Plethora of the Blood-Veſſels, within certain Bounds and Limits, tho it be the Conſequence of a Fever, is yet neceſſary to the Cure; and is owing to the Forecaſt of wiſe and provident Nature, in laying up a Store againſt a time of need, that may enable her to bear the Diſburſments and Expences of a future Criſis.

A FARTHER very conſiderable Proof and Confirmation of this, may be drawn from the Conduct of Nature in thoſe Fevers which take their Riſe from the different Cauſes and Occaſions of Depletion and Repletion.

ALL Experience aſſures us, that when a Fever is brought on by Over-faſting, Watching, violent Exerciſe, loſs of Blood, or any too large Expences of the vital Fluids; or when in the State of a Fever, any great Depletion is occaſion'd by ſymptomatical Evacuations, the Fever is hereby protracted: that is, the ſtationary Period, or the time between the perfect Formation and the Criſis, is lengthned out, and the Fever becomes ſlow and lingring, in proportion to the antecedent Depletion: The Reaſon of which is plainly this, That after ſuch Depletions, it muſt require a longer time for the detaining and locking up the expurgatory Secretions, and for deriving ſufficient ſupplies, from Liquids taken in before the Blood-Veſſels can be ſufficiently

ciently repleniſh'd, the Serum of the Maſs increas'd, diluted, and diſengag'd from the *Craſſamentum*, and Matters prepar'd for a ſafe and ſalutary Criſis, according to the Principles already laid down.

On the other hand, when a Fever invades from any Cauſes or Occaſions of Repletion, it will be more ſhort and acute; and if the Tide riſes not beyond the Bounds and Strength of Nature, a ſafe and good Criſis may be expected: but if it be likely to do ſo, it is the Phyſician's Buſineſs in that Caſe, and in that Caſe only, to check and reſtrain it, ſo far as to keep it within its natural and due Limits, by ſeaſonable and effectual Evacuations.

Now from all this it muſt, I preſume, appear how much they are miſtaken, who think the Cure of Fevers conſiſts chiefly in Depletion and Evacuations, and who ſet about this Work at any time, in every ſtate of the Fever, and without conſidering the Conduct of Nature. And indeed, it is a thing of the greateſt Conſequence, carefully to obſerve and trace the ſeveral Steps and Gradations of Nature, under any particular ſort of Fever, in thoſe who recover of it without the aſſiſtance of Art. And this I ſhall venture to ſay, That no Phyſician can ſtand upon good ground, as to the Method he is to take, or the Succours he is to afford in the Cure of any Fever, till he has diligently obſerv'd, and inform'd himſelf how Nature cures the ſame Fever, when ſhe does the Work without

help; or how ſhe endeavours to do it when ſhe calls for aſſiſtance. But the ſtationary Period of Fevers, or the time between the perfect Formation and the Criſis, being the niceſt and moſt difficult Seaſon of all, and in which, I think, the general Run of Phyſicians are apt to be a little too buſy, I have been ſomewhat the more particular, I hope not altogether unadviſedly, or beſides the Purpoſe, under this Scholium.

PROPOSITION XV.

TO aſſign the moſt general and remarkable Specifications, Forces, and Appearances of Fevers.

It appears from what has been hitherto conſider'd, that a preternatural Heat and Rarefaction of the Blood, attended with an inflammatory Dilatation of the Blood-Veſſels, and a conſequent Compreſſure and Obſtipation of the Lymphaticks and glandular Strainers, are in ſome degree or other the neceſſary Conſtituents of every Fever, with regard to its general Nature and eſſential Form.

Now 'tis evident, that according to the different Degree and Quantity of theſe general Cauſes, or rather eſſential Conſtituents of a Fever, there will be particular Fevers generated, of a higher or lower Rank or Degree, and whoſe Symptoms will be more or leſs numerous, grievous and threatning, in proportion to the Degree of Force, and particular Deter-

Determination of these general Causes. And therefore it would be plainly impossible, and the very Attempt perfectly chimerical, to reduce Fevers to any certain determinate Number, under their proper and specifick Names, so as to exclude any new Forms and Appearances, such as might give occasion for some other specifick Name. 'Tis manifest that from the different Degrees and Quantitys of Rarefaction, Inflammation and Obstruction in Fevers, and the different irregular Flux, and Determination of the Blood and animal Fluids, in particular Cases, innumerable Symptoms may arise, and some new ones every Day which had not been observ'd before. But to dispute in this Case, whether any such new Symptom or Appearance must be allow'd to constitute a new Species; or whether it ought not rather to be consider'd as an Irregularity, under some of the commonly known and establish'd classical Terms and general Sorts; this, I say, wou'd be to raise a Controversy about Words only, which could be of no Use or Consequence at all towards the right understanding and knowledge of Things.

All that can be done here therefore, will be to shew in, or after what manner the different Texture and Cohesion of the Blood, and the different Quantity and Determination of its Motion, will produce different Forms and Appearances in Fevers. And having done this with regard to some of the most

general and ruling Cases, I must leave others to apply the same Method of reasoning to particular Instances, as they meet with them in Practice; and then, according to their Fancy or Humour, they may from the new and different Symptoms or Appearances, either form new and distinct Species of Fevers, under new and distinct classical Names, continually without number; or else with me reduce them all to some few general Heads and first Principles, which I take to be the most natural and rational way.

'Tis well known, that the Blood consists of two very distinct and separate Parts; that is, the *Crassamentum* or *Cremor*, commonly call'd the Globules, and the Lymph or Serum: and that when the Blood is let out, and left to stand and cool in a Bason, the globular Parts which constitute the *Crassamentum*, will unite, cohere, and sink to the Bottom in a coagulated Mass, while the Serum remains on the Surface purg'd and clear'd of its *Crassamentum*. And as it is evident from this Subsidence, that the *Crassamentum* is more dense, or specifically heavier than the Serum; so the same thing has been likewise more fully prov'd, and farther confirm'd from many other Experiments, by the learned Dr. *Jurin*, Secretary to the Royal Society. And from hence it is evident, by a Principle or Law of Nature already establish'd, that these Globules, consisting of the densest Parts of the Blood, or such as contain most Matter in

a given Space, must be endu'd with the strongest attractive Force; that is, the Globules, and the Parts of which they consist, will attract each other mutually, more strongly than they are attracted by the Serum, in which they are immers'd. And this is the Reason why the Globules, when the Blood is left to stand and cool, unite and cohere in larger Masses, and then sink to the Bottom in a Lump of *Coagulum*.

Now in a regular and healthful state of the animal Machine, these Globules, which compose the *Crassamentum*, are kept from uniting, and cohering in larger and denser Masses, chiefly from two Causes.

First, from the expansive Force of the heated Air contain'd in them; and of which no physical part of Bodys, whether solid or fluid, is wholly free, as has been prov'd already. By which expansive or centrifugal Force of the Air, contain'd in the Pores and Interstices of the Blood-Globules, there is way made for some Portion of the Lymph or Serum to enter; and the denser and more solid Particles of the Globules, are kept from coming every where to a Contact, and forming themselves into solid, and too strongly cohering and indissoluble Parts or Corpuscles, as they otherwise would do by the Power of Attraction.

And then, as the expansive Force of the Air tempers and restrains the greater attractive Power of these Globules, and hinders

them from uniting into too large and ſolid Maſſes, ſo the ſame Force acting uniformly throout the whole Maſs, muſt put the Blood into a pretty ſtrong inteſtine Motion; which will keep the Globules equally diſpers'd in the Serum, and retain the Maſs in a due ſtate of Fluxility: and in maintaining and keeping up this inteſtine Motion of the Parts of the Blood, not only the elaſtick Force of the Air contain'd in the Blood, but likewiſe the conſtant muſcular Action of the Veſſels and Solids very much contributes.

But ſecondly, there is another very powerful and effectual Cauſe, which keeps theſe Globules diſunited, in very ſmall Corpuſcles or *Spherulæ*, and hinders them from running into larger and more compact Maſſes by their attractive Forces; and that is, the continual ſtraitning and ſqueezing of the Blood thro the ſmall capillary Arterys: Which fine drawing Pipes or evaneſcent Arterys, are infinitely numerous, and make up by far the greateſt Part of the muſcular and glandulous Fleſh. Now as the Blood can only be ſuppos'd to paſs theſe fine Strainers in a very ſubtile Steam or Vapour, the Diameters of the Blood-Globules will always be kept to the Size and Proportion of theſe extremely minute *Tubuli*; by which means the Globules are attenuated, divided, and diſunited: and then, before they can form themſelves into too large *Spherulæ*, by their attractive Force, they will come to be ſtrain'd and drawn

drawn off in the ſame manner again, as they return to the Capillarys in the Courſe of the Circulation, and ſo on, as far as Nature acts regularly.

THE Globules, or ſmall Particles which compoſe the *Craſſamentum*, being thus attenuated and divided, and kept to a Size and Proportion capable of paſſing the ſmall evaneſcent Arterys into the Veins; the glandular Pipes and Strainers, which are ſtill ſmaller, will admit only of the Lymph or Serum, which is the moſt fluid and ſubtile part of the Blood, and of which the ſeveral Secretions are made.

HAVING thus ſhewn the ſtate of the Caſe in a regular Conſtitution, and where there is no Diſeaſe or diſturb'd Motion; we may now carry the Matter a little farther, and conſider what will be the Conſequence, upon any diſtemper'd Heat and Rarefaction of the Blood, beyond the due Bounds and Meaſures of Nature.

NOW 'tis evident that upon any increaſed Heat and Rarefaction of the Blood, the Globules, of which the *Craſſamentum* conſiſts, muſt ſwell, dilate, and enlarge their Dimenſions; and being thus expanded and enlarg'd in bulk, they will imbibe and retain the thinner and more fluid Parts of the Lymph or Serum: But the thinner Parts of the Serum being thus abſorb'd, and retain'd in enlarg'd and expanded Globules, the remaining Part of the Lymph muſt neceſſarily be the more

thick

thick and viſcid; which Viſcidity muſt be increas'd, in proportion to the increaſed Heat and Rarefaction of the Blood; as is manifeſt by putting any Portion of the Serum over a Fire, and expoſing it to a moderate degree of Heat, ſomewhat beyond the natural Heat of the Blood; by which means, the greater part of the Serum will be viſibly thicken'd, and turn'd into a ſort of viſcid tenacious Gelly.

Now the thinner Parts of the Serum being thus taken up by the expanded Globules, and the Viſcidity of the Remainder increas'd by the Heat and Rarefaction, 'tis plain that the Drain of Lymph thro the Glands will be diminiſh'd; and the diſtended Blood-Veſſels, preſſing at the ſame time upon the Glands, the Lymphaticks and glandular Canals will be conſtipated and obſtructed, more or leſs, according to the different Force and Degree of the obſtructing Cauſes. And ſince in this Caſe the enlarged Globules and viſcid Serum will paſs with more difficulty thro the ſmall capillary Arterys, theſe fine Tubes muſt be hereby dilated beyond their natural due Capacity, which muſt excite the Senſe of an hot, painful Diſtenſion or Tumefaction of the Veſſels.

But farther, ſince a great many of the expanded Globules may become too large to paſs the finer evaneſcent Arterys, they muſt neceſſarily be pent back, and oblig'd to paſs thoſe larger Veſſels, which being more open and capacious, will be diſpos'd to receive them;

them : and by this means the heated *Craſſamentum* will be thrown in a greater Quantity and Proportion on ſome Parts than on others, which muſt break and deſtroy the *Æquilibrium* of the circulating Blood ; and this will produce a ſenſible *Luctus* and Perturbation of Motion, an unequal Pulſe, and variouſly mix'd, and irregular Degrees of Heat and Cold, with ſeveral other of the common Phænomena, and Symptoms of Rarefaction and Inflation.

But if we ſuppoſe the Heat and Impetus of the Blood, and the Force and Action of the Muſcles to be carry'd farther, ſo as not only to expand and enlarge the Globules, but to break, diſſolve, and divide them into the ſmalleſt Parts, and mix them ſo cloſely and intimately with the Serum, that they cannot be ſeparated in the Secretions ; this muſt induce a moſt diſmal and grievous train of Symptoms, ſuch as are incident to Fevers of the higheſt rank and worſt kind ; and which according to their Degree and Meaſure, or ſo far as they prevail, muſt quite ſubvert, and deſtroy the moſt neceſſary and eſſential Conſtitutions of the animal Kingdom.

Now if theſe Globules, which conſtitute the *Craſſamentum*, are only broken, and divided to ſuch a Degree as to increaſe the Rarefaction of the Blood, and Diſtenſion of the Veſſels, but ſtill to retain a bulk and ſize too large to enter the Lymphaticks and glandular Strainers ; the conſequence of this beginning

Colliqua-

Colliquation and Diſſolution, will be a very great and extraordinary degree of Heat, Tumefaction and Inflammation, extreme Drought, burning Thirſt, a very irregular Pulſe, ſometimes exceeding high, and at other times ſcarce ſenſible; violent Efforts and Outrage, with other Appearances of a like nature, conſequent upon ſuch a Degree of Heat and Rarefaction, too obvious to be here inſiſted on.

But if this Comminution and Diviſion of the Blood-Globules proceeds farther, to ſuch a perfect Solution and Colliquation of the *Craſſamentum*, as to render it capable of paſſing the Lymphaticks and fine glandular *Tubuli*, the conſequence of this will be bloody Secretions; a gradual Repletion of the Lymphaticks and glandular Canals with Blood; ſudden Mortifications, Eroſions, and Gangreens of the Fleſh, with burning, cauſtick Swellings, and Tumors of the Glands and Tendons; and all thoſe Symptoms which are the common and well-known Appearances and Indications of the higheſt Malignity, Inflammation, or peſtilential Heat.

The better to underſtand this as the true ſtate of the Caſe in peſtilential Fevers, let it be obſerv'd here, that Nature has taken all imaginable Care, and made all poſſible Proviſion for retaining the *Craſſamentum* in the Blood-Veſſels, and to prevent its being ſeparated and drain'd off, together with the Lymph or Serum, in the ſeveral Secretions; and therefore as this never happens in ordinary Caſes, ſo when-

whenever it does happen in any considerable Degree, the Danger is imminent, and it may be look'd upon as the Prelude and Forerunner of Death.

PHYSICIANS need not be told that this is so in Fact, since all Experience testifys it, and every one of the least Observation must be sensible of it. And that it must be so from the Nature and Reason of the thing, will appear, if we consider the most distinguishing sensible Qualitys of the *Crassamentum*, and how it differs from the Serum.

THAT the Globules, of which the *Crassamentum* is made up, consist of very small, dense, or solid Corpuscles, or Particles, with a small Portion of Lymph or Serum included, is certain in Fact, and so commonly known, that there can be no need to insist on the Proof of it here. Now these Globules, consisting of the most dense, compact, and solid Parts of the Blood, 'tis evident they must be capable of receiving a greater Degree of Heat, and being once heated, they will retain their heat longer than any other parts of the Blood; this being the well-known Property of dense and compact Bodys. And as the greatest Density must make these Globules the Subject of the greatest Degrees of Heat in the Blood, so it must give them the greatest Force of mutual Attraction and Cohesion; by which, in the ordinary and regular Course of Nature, they will form themselves into pretty large *Spherulæ*; which will hin-

der them from passing the Glands, and retain them in the Blood-Vessels, where alone they are capable of serving any of the Offices and Purposes of Animal Life. And therefore Nature has furnish'd the Blood-Vessels with very thick and strong Coats, and endu'd them with a considerable muscular Force, to enable them to bear the Heat, Impetus, and Resistance of these Globules; and to give them such a Degree of Motion and Agitation, as may be sufficient to keep them disjunct and separated, and hinder them from uniting, and running into larger and denser Masses.

And as this shews the Reason and Necessity of retaining these hot and dense Globules in the Blood-Vessels, so it gives us at the same time an easy Solution of those fatal and mischievous Consequences which ensue, when in a preternatural and violent way they pass off in the Secretions, and come to be lodg'd in the Lymphaticks and glandular Canals.

These Lymphaticks and secretory Ducts of the Serum therefore, being provided but with very thin, soft, and tender Coats, or Membranes, as design'd only for the slow and easy Conveyance of a cool diluting Lymph; 'tis easy to imagine what will be the Consequence, when they come to be fill'd and obstructed with such a Substance as is that of the *Crassamentum*, or Blood-Globules. For these minute, dense, and elastick Globules, having been extremely heated in the Arterys, by the Rage and *Luctus* of the Fever, and

being now drain'd off, and lodg'd in the Lymphaticks and ſecretory Ducts of the Glands, and there ſtrongly compreſs'd and put into a violent inteſtine Motion, by the Dilatation and Diſtenſion of the Blood-Veſſels, and not being able to move forward in the Courſe of Circulation; 'tis evident, that the ſoft and tender Coats of the Lymphaticks and ſecretory Ducts, will not be capable of reſiſting and ſuſtaining the Force and Action of the Globules under theſe Circumſtances; which would require all the Strength and Effort of the Arterys themſelves. And conſequently the Blood, having been thus heated and inflam'd in the Arterys, and then thrown out into ſuch wrong Channels, it muſt prove corroſive and cauſtick to theſe fine, thin, and tender Tunicles. And this muſt induce Eroſions, Mortifications, Gangreens, hot burning Tumors, purple, black, or livid Spots upon the Surface of the Skin; which are the corrupt, bloody Secretions of the cutaneous Glands, with the whole Train of diſmal Symptoms, which are the too common and well-known Appearances of Malignity, or peſtilential Inflammation.

Now in the firſt of theſe Gradations, where the Heat and Rarefaction of the Blood is ſuch as only to ſwell and dilate the Globules, of which the *Craſſamentum* conſiſts, without breaking, dividing, and diſſolving them; I call this a *Flatulent* Fever, as being the Effect only of Rarefaction and Inflation.

In the ſecond Gradation, where the Globules and Corpuſcles of the *Craſſamentum* are in great meaſure broken, comminuted and diſſolv'd, ſo as to induce the more grievous and threatning Symptoms, which follow from a greater degree of Heat and Rarefaction, and a greater and more general Obſtruction of the Glands, I chuſe to call this Conſtitution and State of the Blood, a *Colliquative* Fever.

But where there is ſuch a general and perfect Solution of the *Craſſamentum*, as to produce bloody Secretions, Eroſions, Gangreens, hot burning Tumors, *&c.* I ſhall give this Conſtitution the Name or Denomination of a *Cauſtick*, Malignant, or Peſtilential Fever.

Another general ground or principle of Diſtinction and Diviſion in Fevers, ariſes from the different Determination of the Blood in the Courſe of its Circulation, with reſpect to its Afflux and Reflux to and from the Head, and extreme Parts or Surface of the Body.

The Blood in Fevers is ſometimes thrown violently upwards and outwards, or deriv'd in too great a Quantity and Proportion to the Head and extreme Parts; which appears in delirious Ravings, great Strength, an high Pulſe, and a burning Heat of the Fleſh and extreme Parts; and at other times it is thrown downwards and inward, thro the deſcending Trunk of the *Aorta*; while the Head and extreme Parts are depriv'd of their due Share and Proportion of Blood, and left cold and languid, with a weak low Pulſe, loſs of Strength,

Strength, comatose Dotings, and frequent Twitchings and Convulsions of the Parts: That is, the *Æquilibrium* of the Blood in Fevers is broken, interrupted, and disturb'd in the Course of its Circulation; and this happens by its being thrown in too great a Quantity and Proportion, either thro the ascending or descending Trunk of the *Aorta*. Now the first of these general Constitutions, or Perturbations of Motion, I call an *Effluent*, and the other an *Influent* Fever.

Now it is evident, that of the five Febrifick Constitutions, the two latter may be variously mix'd and complicated with the three former. For a Flatulent, Colliquative, or Caustick Fever, may either of them be Effluent or Refluent: that is, the particular, febrifick Disposition, as to its main Force and Efficacy, may be either thrown outward upon the Flesh and extreme Parts, or inward upon the Stomach, Intestines, and the several Bowels and complicate Organs contain'd in the Abdomen; and from hence there will arise six compound, or complicate Constitutions, namely, the *Efflatulent* and *Influtulent*, the *Effluccolliquative* and *Influcolliquative*, and the *Effluent* and *Influent*, *Caustick*, Malignant, or Pestilential Fever.

Having here deriv'd these several sorts of Fevers from that real, internal Disposition of the Blood, and State of the animal Machine, and from that peculiar Perturbation of Motion, which forms this or that particular, febri-

fick Conſtitution, and is the proper Ground or Origin of all the Symptoms, or ſenſible Appearances; I have been oblig'd to adopt ſome few Names or Denominations, which had not been thus us'd or apply'd before: And this I found my ſelf under a ſort of Neceſſity to do, as not knowing otherwiſe how to expreſs clearly and intelligibly what I aim'd at. But if any one ſhould reckon this Innovation a Fault, he will be at liberty to make uſe of any other Terms, ſuch as may be more proper and leſs exceptionable, if he can find them: For provided the Nature and Reaſon of the Thing be duly kept by and regarded, I ſhould not be at all diſpos'd to quarrel with any body about Words.

It may not be amiſs perhaps here, to take a little notice of ſome common Denominations of Fevers, which are taken from the Parts chiefly affected. For where the Fever is moſt remarkably thrown upon ſome principal, complex Organ, whoſe Office and Function is abſolutely neceſſary to Life, that Organ is conſider'd as the primary Seat, and *Fomes* of the Diſeaſe; and the Fever receives its Name from it accordingly: Thus a *Peripneumony* is denominated from an Inflammation of the Lungs, a *Pleuriſy* from an Inflammation of the Pleura, *&c.*

But as theſe Fevers are only for the moſt part particular Symptoms, and Appearances of ſome more general febrifick Conſtitution, to which they ought to be refer'd, and with-

out

out which they can neither be underſtood nor cur'd; there is no need to enlarge upon them here. This, however, may be worth obſerving, and which I can pronounce upon Experience, that either in a Peripneumony or Pleuriſy, the common fam'd Bronchials and celebrated Pectorals are of little or no uſe, how much ſoever they may be cry'd up and depended on. But a Derivation by Bliſters, and moderate Catharticks, under a judicious Management ſeldom fail; and particularly in a Pleuriſy, a large Bliſter apply'd to the pain'd Side, will give a more effectual and ſpeedy Relief than any other Method whatever.

I KNOW the Generality of Phyſicians in this Caſe fall directly upon Bleeding, in large Quantitys; and repeated as occaſion ſerves; and I muſt not deny that this Method is often ſucceſsful. But I am well aſſur'd there can be no neceſſity for it, unleſs there be an Effluent Colliquative, or ſome plain Indications of effluent Malignity: but otherwiſe this Fever may be *as well* apply'd to, if not much *better*, without Bleeding than with it.

THE *Variolous* Fever, or that which attends the Small-Pox, is an Effluent of a peculiar Conſtitution: but with reſpect to the Texture and Coheſion of the Blood, or the different Proportions of the attractive and expanſive Forces of the Blood-Globules, it is capable of any degree in that kind, and may be either a ſimple Flatulent, and a Colliqua-

tive, or ſometimes even Cauſtick and Malignant. And upon this Gradation of the Fever, the Nature and Kind of the Puſtles, as diſtinct or confluent, large or ſmall, the Duration of the ſtationary Period from the Formation to the Criſis, and the whole Complex and Proceſs of the Diſeaſe will entirely depend.

WHERE the Diſeaſe is attended only with a mild and moderate Efflatulent, as ſoon as the Irruption is finiſh'd, and the main of the Puſtles have made their Appearance, the Fever ceaſes, or at leaſt continues but in a very low and almoſt inſenſible degree. For in this Caſe the Blood condenſing, and the Globules of the *Craſſamentum* recovering their natural attractive Force, the vitiated Serum will quickly and eaſily paſs off by the excretory Ducts, and fill up the Puſtles, which will be both large and diſtinct, and come to their Maturity about the eighth Day from the firſt Invaſion of the Diſeaſe.

IF the efflative Force of the Blood riſes ſtill higher, but without any thing of a Colliquation, the Irruption will be ſlower, the Fever continue longer, the Puſtles, tho diſtinct, will be of a ſmaller ſize and more numerous, and the time of their Maturation protracted to the eleventh or twelfth Day: And the Reaſon is plain; becauſe in this Caſe the morbid Serum, which ought to fill up the Puſtles, cannot eaſily paſs off and diſengage it ſelf from the adhering rarefy'd *Craſſamentum*.

WHERE

WHERE the effluent Force of the Blood is ſtill increas'd, ſo as to run into Colliquations of the *Craſſamentum*, and a ſtronger and more intimate Coheſion of the Globules with the Serum, the Pox will be of the Confluent kind; and according to the Strength and Degree of this Conſtitution, the Symptoms will be higher and more ſevere, the Fever protracted and continued, the Criſis deferr'd to the fifteenth, eighteenth, or even to the twenty firſt Day, and perhaps ſometimes longer; and the Diſeaſe will, in proportion to its Strength and Degree, put on all the Appearances of colliquative and malignant Fevers.

NOW the Grounds and Reaſons of all this, and from what Gradations of the internal Conſtitution the various gradual Symptoms and Appearances ariſe, is ſo evident from what has been already conſider'd and explain'd, that to inſiſt farther on this Matter, would be to ſuſpect the Underſtanding of my Reader.

COROLLARY.

FROM hence it appears, how exceeding hurtful and miſchievous a Practice it muſt be, to give large and frequent Doſes of Alexipharmicks, and hot rarefying Sudorificks, under a Pretence of driving out and keeping up the Puſtles; ſince 'tis manifeſt, from what has been ſaid, that the too great Rarefaction of the Blood, and conſequent too cloſe and intimate Mixture and Coheſion of the *Craſſamentum* with the Serum, is the main Cauſe

that hinders, interrupts, or protracts the Secretions in this Diſeaſe, aggravates and heightens the Fever, and renders the Pox of the worſt kind. All which being promoted and brought in by this heating Method, it is evidently deſtructive, and contrary to Nature.

And from hence it likewiſe appears of how great Conſequence it muſt be in this Diſtemper, eſpecially in the worſt ſort of it, for the Patient to drink plentifully all along of cool diluting Liquors; ſuch as, conſidering the State of the Diſeaſe, and Cuſtom and Conſtitution of the Perſon in his Health, the Phyſician ſhall judge moſt proper: ſince without this Proviſion, the Quantity and *Momentum* of the Blood will be ſo far leſſen'd by the great Expence of Serum, in the mighty Load that is thrown upon the Surface of the Body, that there will not be a ſufficient internal Force to carry on and compleat the Diſcharge. And this is the true Method in this Caſe to ſecure a good Criſis, and not that unnatural Fluſh, and falſe Appearance of Strength, which is given to the Blood by Alexipharmicks.

An *Hectick* is a very ſlow, and gradually advancing Fever, attending the Scurvy, when that Diſeaſe fixes either upon the Lungs and Bronchia, or upon the Lymphaticks and chyliferous Ducts. The Hectick therefore is not a Fever originally and in it ſelf, but ſymptomatically only, and in conſequence of that Scorbutick Conſtitution, by which it is generated

rated and form'd. Here then, to underſtand the Nature of an Hectick, it will be neceſſary to reflect a little upon the Scorbutick Conſtitution, of which the Hectick is properly a Symptom only.

Now in the Scurvy, contrary to what happens in Fevers, the *Craſſamentum* of the Blood is condens'd, and the attractive Force of the Globules increaſed; and the Serum being vitiated, and render'd ſharp and acrid, by the too great Quantity of Salts which it contains, is with ſuch a Diſpoſition diſcharg'd too faſt, or thrown off by the ſeveral Secretions, in a greater Quantity and Proportion than what is juſt and natural. While the Lymphaticks and glandular Canals are overcharg'd with a ſalt, acrid, corroſive Serum, the thinner Parts being thrown off, the thicker will be left behind, and form Nodes, Tumors, and eroding Concretions, which occaſion an Ulceration of the Glands, and produce the ſeveral Symptoms of a Scurvy.

Now the Scurvy once form'd, and having fix'd it ſelf upon ſome of the principal Glands, and neceſſary Organs of Life, generates an Hectick after this manner: The Serum and thinner Parts of the Blood being carry'd off continually, in larger Quantitys than ordinary, the *Craſſamentum* in proportion to the Serum muſt ſtill increaſe: but the *Craſſamentum*, or Globules, being the hotteſt part of the Blood, as this encreaſes in proportion to the Decreaſe of the diluting Serum,

the Heat must likewise increase; that is, a Fever must be rais'd, and the Erosion and Ulceration of the Glands, especially when this Erosion falls upon the Lungs, thro which the whole Mass of Blood is oblig'd to pass, it must still increase the Heat, while it hastens and promotes the Discharge of the remaining Parts of the Serum. Till at length the fluid Stores of Nature being exhausted, the principal Organs eroded, and ulcerated, and the solid, elastick, nervous Fibres parch'd, exsiccated, and render'd too stiff, tense, and unfit for Motion, a sort of old Age is induc'd, tho in the midst of Youth; and the Person dies enfeebled, emaciated, and in a manner scorch'd and dry'd up.

Now from this short Theory, the chief Intentions of Cure in an Hectick are plainly these.

I. To cleanse, unite and heat the eroded Glands and excretory Ducts.

II. To carry off the saline Recrement of the Blood, especially thro the Kidneys, which are their principal Outlets and proper Strainers.

III. To qualify and mitigate the intemperate feverish Heat.

IV. To repleniſh the exhausted Vessels with a sufficient Quantity of wholesom Chyle, and proper Nourishment.

V. To

V. To ſtrengthen and confirm the Habit by proper Exerciſe, and a right uſe of the Nonnaturals.

With reſpect to the two firſt of theſe Intentions, which ought likewiſe to be primarily and chiefly regarded in Practice, I ſhall take leave to obſerve here, that amidſt all the numerous Train of ſimple and compound Remedies, ſo highly cry'd up, and ſo much recommended by the ſeveral practical Writers, under the Name and Notion of Antiſcorbuticks, there are none which can in the leaſt be compar'd with ſome of the Mercurial and Antimonial Preparations; eſpecially the Æthiops, Cinnabar, Diaphoretick Antimony, and the *Antihecticum Poterii*. And he who ſhall go about to cure a Hectick without a primary and chief Regard to the Scurvy, of which it is a Symptom, will find himſelf unhappily miſtaken, to the great Loſs and Detriment of his Patient. And from hence we may eaſily account for the general unſucceſsfulneſs of thoſe, who in the Cure of an Hectick, fall directly upon the uſe of aſtringent Balſamicks, and agglutinating Mucilages, which ſerve only to clog the Viſcera, thicken the Blood, and fix the corrupt Serum upon the eroded enfeebled Glands; while the Caſe plainly requires, and Nature loudly calls for ſuch a powerful Deobſtruent, and wonderful Sweetner, as that of Mercury. But as for thoſe who will ſtill obſtinately perſiſt

ſiſt in their old heating way, I ſhall only beg them to conſult the Surgeons.

But it will be neceſſary here to conſider a little more diſtinctly the Formation and different Appearances of ſuch ſecondary, ſymptomatick, or glandular Fevers, of which the Hectick is only a particular Sort or Species: For as theſe Fevers are generated from either the hydropick or ſcorbutick State and Diſpoſition of the Blood, 'tis manifeſt they will be of different kinds, and either Acute or Chronick, according to the different Degree and Meaſure of the general Conſtitution from which they proceed, and the various Parts or Organs chiefly affected.

After what manner the morbifick Heat and Rarefaction of the Blood, enlarges the Blood-Globules, imbibes and retains the Serum, and diminiſhes or interrupts the glandular Secretions, has been ſhew'd already; and the ſeveral Species and Appearances of original legitimate Fevers from thence deduced: but 'tis plain that any ſudden Condenſation of the Blood by Cold, increaſing the attractive Powers of the Globules, as the Force and Action of the expanſive Elements are diminiſh'd, muſt have a contrary Effect, and diſpoſe the Serum to paſs off faſter and quicker than ordinary thro the glandular ſecretory Ducts, or ſtraining Pipes; from which too quick and large Secretion, there muſt enſue a Surcharge of the ſecreted Matter upon the glandular Lymphaticks and Aqueducts, occaſioning

ſioning a painful Diſtenſion and Tumefaction of the Glands thus affected: In which Caſe, the too quick and large Secretion from the over-cool'd condens'd Blood continuing, while only the thinner and more fluid Parts of the Secretion paſs off, the groſſer and thicker Parts of the Lymph or Serum will lodge upon the diſtended dilated Veſſels, and increaſe the Inflammation and Tumor, till the obſtructing Matter be either diſſipated and carried off by proper Diſcutients, or brought to a Suppuration, and diſcharged by an Abſceſs.

Now from the general Cauſe here aſſign'd, 'tis evident that various ſorts of Fevers may ariſe with different Appearances, which will be properly ſymptomatical of ſuch Inflammations and Tumors of the Glands, tho the Blood be not otherwiſe at all over-heated and rarefy'd, but on the contrary chill'd and condens'd; and tho the other Secretions continue regular, and in their natural State. All which Fevers generally paſs among the Vulgar under the common Name of *Colds*; and that not very improperly, ſince an irregular unequal Condenſation of the Blood by Cold, is certainly the common Cauſe of them all: tho they will be of various ſorts, Acute or Chronick, Effluent or Influent; and attended with different Phænomena or Symptoms, according to the different Degree of the Condenſation, Diſtenſion, and Inflammation; the different Parts or Organs principally affected, and the different Habit or Conſtitution of the Patient.

THE antecedent Cauſes or Occaſions of this morbifick Conſtitution, are chiefly ſuch as theſe; *viz.* a cold, damp, piercing Air, in which the nitrous Salts being minutely diſſolv'd and diffus'd, paſs together with the Humidities of the Air into the Blood.

SITTING or lying upon the Ground in a cold, ſhady, or moiſt Place; eſpecially while the Body is hot, and the Blood rarefy'd with Exerciſe, or the Heat of the Seaſon.

DRINKING too freely of cold Small Beer, or Water, in a hot, rarefy'd, and ſweating State and Diſpoſition of the Blood; and reſting after it, or neglecting to keep up the Heat and Efflatus of the Blood, till the condenſing Power of the cold Liquor be ſubdu'd and carry'd off.

THE too large and liberal eating of any ſharp, raw, and unripe Fruits and cold Sallads; eſpecially Cucumbers without their warmer Correctives.

THE going open with the Boſom, or expoſing the Breaſt to a cold, damp, or foggy Air.

BUT above all, that general Conſtitution of the Air diſpoſes to theſe Fevers, which is occaſion'd by the ſudden Fall of large and plentiful Rains, after a long hot and ſcorching Seaſon: For here the Blood and animal Liquors having been very much rarefy'd, and raiſed to a high degree of Efflatus by the preceding Heats, are ſuddenly cool'd and condenſed by the cold, moiſt, nitrous Air ſucceeding upon the

the Rains: by which means, great Quantitys of hot ſharp Serum being thrown upon the Glands, and there ſtagnating and corrupting, produce various ſorts of inflammatory Tumors and Ulcerations. In which Caſe they muſt expect to be the greateſt Sufferers, who are of the moſt tender and delicate Conſtitutions; who clothe warm, keep for the moſt part within Doors, avoid Exerciſe, ſpend their Time in a continual Round of luxurious Idleneſs, and according to the common Phraſe, *live well*; that is, to *no purpoſe*. For ſuch good Livers having by Lazineſs and Luxury already clogg'd the glandular Organs and muſcular Springs of Motion, with Loads of dull Phlegm, Flatulencys and Indigeſtions, when freſh Fewel comes to be added from any of the foregoing Occaſions, they are preſently torn to pieces; and the crazy lumpiſh uſeleſs Carkaſs is ſacrific'd to the Deſtroyer without remedy.

THE Blood being thus ſuddenly condenſed, and its Serum thrown exceſſively upon the Glands, as the condenſing Power of the Cold happens principally to affect ſometimes one Part and ſometimes another, a Fever will ariſe from the inflam'd, tumefy'd, eroded Glands, and diſcover it ſelf by ſome of theſe following Symptoms.

INFLAMMATIONS, Swellings, Abſceſſes about the Mouth, Face, Neck, and Throat; Hoarſneſs, violent Coughs, great Depreſſion with a Senſe of Weight upon the Breaſt, and

difficulty of Breathing: Sometimes at first Vomitings and a Diarrhæa, which are soon follow'd with an obstinate Costiveness, and a hard tensive Tumefaction of the Belly; Cholick Gripes, and Spasms of the Stomach and Intestines; a low, unequal, and tremulating Pulse; Coldness in the extreme Parts, and a livid Paleness of the Face and Skin; extreme Drousiness, and comatose Stupor; a paralytick Deadness, and Relaxation chiefly on one side. After which, the Patient dies convulsed, and under a stupefy'd drousy Raving.

All these Symptoms do not appear in all the Fevers of this glandular or condensative kind, but more or fewer, and with greater or less Severity, according to the Strength and Degree of the Condensation, the Parts affected, and the previous Habit or Disposition of the Body. Where the Distension and Tumefaction happens only upon the Parotid, Jugular or Maxillary Glands, the Fever is generally mild and benign; and easily carry'd off at first by Sweating, and a Blister upon the Neck: but if this has been omitted, as soon as the principal Tumor ripens and discharges it self outwardly, the Fever for the most part goes off, and all farther Danger is prevented by giving a Purge or two.

But where the glandular Inflation or Tumefaction lies deeper in the Lungs or Breast, which may be known by the painful trou-

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bleſom dry Cough, Depreſſion of the Breaſt, and difficulty of Breathing; in this Caſe, where the Tumor cannot be ſafely brought to an Abſceſs, and diſcharg'd outwardly, care muſt be taken to divert the Matter before it comes to an Abſceſs: to which purpoſe, the moſt effectual means is to apply without loſs of time, a large ſtrong Epiſpaſtick as near as may be to the Part affected; and at the ſame time to give, every three or four Hours, a ſmall Doſe of ſome proper Alexipharmick made gently opening. I have often found the following very efficacious, which I therefore recommend for the ſake of the leſs experienc'd.

℞ *Lapid. Contrayerv.* ʒ iii.
Rad. Serpent. Virg. ʒ ii.
Rhab. ʒ i. *Miſce. fiat pulvis.*
Divide in Chartulas, N° 12.

THIS may be made more or leſs opening, as the Caſe appears to be more or leſs inflammatory, either by leaving out the *Serpentaria*, and ſupplying the Compoſition with *Rhubarb* and *Sal Prunel* of each ʒ i ſs. or by leaving out the *Rhubarb*, and putting the *Serpentaria* in equal Quantity with the *Lapis Contrayerva*.

THE common Drink may be Mutton, Veal, or Chicken Broth, Sack Whey, or Tea made with Sage and Buck-Bean, adding a little White Wine. But if the Caſe be inflammatory, and attended with an effluent

Heat, an high Pulſe and ſpitting of Blood, as it ſometimes happens; equal Parts of Milk and Water boil'd together, and made into a thin Emulſion with the Pulp of roaſted Apples, are extremely well adapted to the Intention, and as a cooling opening Pectoral, are vaſtly preferable to all the more famous and celebrated Pectorals of the Shops, how much ſoever they may be admir'd and cry'd up in ſuch Caſes.

But this morbid Conſtitution often lies yet deeper, and fixes chiefly upon the inteſtinal and meſenterick Glands; and then it diſcovers it ſelf by an hard tenſive Tumefaction of the Abdomen, Cholick Gripes, and Spaſms, obſtinate Coſtiveneſs, the ſinking of the Pulſe, the retiring of the natural Heat, and the moſt extreme Weakneſs and Languor, while the Patient is ſtill ſenſible, and without much of a *Coma* or Delirium.

In this Caſe Epiſpaſticks muſt be apply'd with all their Force, the ſtronger Alexipharmicks exhibited, Drinks impregnated with volatile oily Salts allow'd, with Opiates in ſufficient Quantitys: that is, all proper means muſt be uſed to take off the *Stimulus*, to raiſe the Pulſe and natural Heat, to derive the Stream and Efflatus of the Blood outward, and thereby to prevent the too great and continued afflux of ſharp vitiated Serum upon the inteſtinal and meſenterick Glands, which otherwiſe threatens a ſpeedy Excoriation, Gangreen, Mortification, and Death.

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Where this Method in the preſent Caſe has been too long neglected, all farther Attempts will be vain; for when the internal Mortification comes on, the ſtrongeſt Epiſpaſticks will have no Effect; but ſoon after they are taken off, the Fleſh under them becomes pale, livid and dry, like the other Skin: upon which Appearance, after Bliſtering, the Phyſician may ſafely pronounce moſt certain Death, and that the End of the whole Tragedy is very near at hand.

PERHAPS it may not be amiſs here, by way of Illuſtration, to give the Hiſtory of a Greyhound, which having been exceedingly heated in a hard Courſe, preſently took Water, and lap'd a conſiderable Quantity before he could be got out of the Pool: upon which he was immediately ſeiz'd with extreme Weakneſs, Faintneſs and Trembling, and with a total Obſtruction in the Bowels, ſo that nothing could paſs thro him: And growing ſtill worſe, he ſoon expir'd under the moſt grievous Convulſions. Upon opening, the Stomach and all the other Parts contain'd in the Abdomen were found perfectly ſound and good, excepting the Meſentery, which was exceedingly tumefy'd, and enlarg'd to four or five times its natural Bulk and Weight, and at the ſame time inflam'd and mortify'd: by the great Tumor and Diſtenſion of which, the Bowels were ſo conſtipated and compreſs'd, as to be render'd impervious and totally obſtructed. Now how this came about,

is very evident from what has been ſaid; for the Dog ſwimming into the cold Water, and taking it into his Stomach while he was thus hot and reeking, the Blood, which was extremely heated and rarefy'd, was hereupon ſuddenly chill'd and condens'd: by which a greater Quantity of the cool'd diſſolv'd Serum was thrown in upon the meſenterick Glands than could poſſibly paſs off again; which reduced the Meſentery to that tumefy'd, inflam'd, and mortify'd State in which it was found, and which was plainly the Cauſe of all thoſe grievous Symptoms that manifeſted the Injury the Creature had receiv'd.

THERE is yet a farther Degree of this glandular Inflation and Tumefaction, or quick and immoderate Afflux of the Serum upon the Glands and Lymphaticks; and that is, where the Inundation happens upon the cerebral Glands, and the Lympheducts of the Brain it ſelf. In this Caſe, the Drouſineſs, Delirium, languid Reſtleſneſs, and paralytick Symptoms, increaſe in proportion to the Riſe and Progreſs of the Obſtruction, Inflation, and Tumefaction of the cerebral Glands and Lympheducts; till at laſt the Glands mortify, or the Lymphaticks break and let out a Deluge of Water upon the Brain, which renders the Caſe altogether hopeleſs and deſperate.

IN this hydrocephalick Fever, as I chuſe to call it for the Reaſons already aſſign'd, the only Method I have hitherto found to prevent

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the worſt, and effect a Cure, is by applying a large ſtrong Epiſpaſtick to the whole hinder part of the Head, ſo as to come up as far as the Crown, like a backward Cap or Coif. If this be done while the Patient is yet ſenſible, and before the comatoſe, delirious, and paralytick Symptoms appear, the Bliſter for the moſt part runs well, draws off great Quantitys of ſerous Matter, and the Patients generally recover. But after the forementionʼd Symptoms are come on, I have never found a Bliſter riſe or produce any Effect, how large or forcible ſoever it may be made: and the Reaſon is, that when the cerebral Glands begin to mortify, and the Lymphaticks break, there enſues ſuch a large Draught and Efflux of Lymph upon the Brain, that no Serum can by any Force be derivʼd outward, or drawn off by the Epiſpaſtick; and this I have found evidently confirmʼd to Senſe, and by Experience, upon Diſſection.

THIS ſort of Fever, or rather this degree of an acute glandular condenſative Fever, generally comes on with Vomiting and Purging; as if Nature intended to relieve her ſelf by that means: tho theſe Symptoms quickly diſappear, and are ſucceeded by an obſtinate Coſtiveneſs, and the Patient has no Stools but what are forced. I am therefore apt to believe, that an Emetick and Cathartick given immediately upon the firſt Attack might be of great ſervice, but have never had an opportunity to make the Trial, as having ne-

ver been call'd ſoon enough in any ſuch Caſe. But this I know, that after the Fever has fix'd it ſelf for a few Days, neither Vomiting, Purging, Bleeding nor Sweating, are of any uſe; but Bliſtering, eſpecially on the Head, in the manner already mention'd, is the only Method that I have yet obſerv'd any the leaſt apparent good Effect from.

BOTH theſe two laſt mention'd Species or Gradations of an acute condenſative Fever, I mean the Hydrocephalick and the Hydromeſenterick, often meet together, and diſcover themſelves in their different and reſpective Phænomena and Symptoms: and where this happens to be the Caſe, their reſpective Methods of Cure muſt be comply'd with, and jointly purſu'd; which having been already conſider'd diſtinctly, need not here be farther inſiſted on.

INTERMITTING Fevers or Agues, are a compound or mix'd Species, participating partly of the arterial rarefactive, and partly of the lymphatick condenſative Kind: They generally attack People like glandular condenſative Fevers upon taking Cold, and are eſpecially fed and nouriſh'd by a cold, ſaline, damp, and fenny Air: they who are not uſed to ſuch an Air, or to whom it is not natural and conſtitutional, upon going into it, and continuing in it for a time, ſeldom fail of catching theſe Intermittents; which are ſometimes very obſtinate, and terminate at laſt either in the hydropical or ſcorbutick Habit; and run into

into ſuch ſlow, lingring, and hectical Fevers of the glandular kind, as commonly attend thoſe Conſtitutions.

AGUES, as every body knows, begin with a cold compreſſive Shivering, which laſting for about an Hour, ſometimes more, ſometimes leſs, is ſucceeded with an hot burning Fever, of the arterial and effluent kind. The Patient having been for ſeveral Hours ſcorch'd and tormented with this febrifick Paroxiſm, he is at laſt perfectly reliev'd for the preſent by the Irruption of large critical Sweats, after which all the Symptoms diſappear till the Fit returns in the ſame manner, either the next Day, or with the clear Intermiſſion of one or two Days: from which variety in the periodical Returns, they receive the different Denominations of *Quotidian*, *Tertian*, and *Quartan* Agues. During the cold Fit, the Pulſe is quick, ſmall and low, in proportion to the depreſſing condenſing Power of the Cold; but afterwards it riſes and ſtrengthens proportional to the Strength and Violence of the conſequent Fever. From the firſt attack the Perſon is affected with great Thirſt, extreme Sickneſs at Stomach, Nauſeas and Vomitings, which continue till the breaking out of the critical Sweats, and then are ſuſpended till the next Return of the Fit.

THESE Vomitings diſcharge conſiderable Quantitys of a cold indigeſted Slime, or viſcid ſaline Gelly, which is more or leſs mix'd with Bile; as to which it muſt be obſerved,

that the bilious Vomitings in Agues, are the moſt ſalutiferous, and indicate the mildneſs of the Diſeaſe: but where the cold ſlimy Lentor, or viſcid fix'd ſaline Gelly abounds, the Diſtemper is the more obſtinate, and harder to be cur'd. And this is commonly the Caſe in Autumnal Quartans, which are well known to be the worſt and moſt inveterate of all Agues.

BLEEDING and Purging are of no uſe, but for the moſt part extremely prejudicial in Agues; ſince they are found to weaken the Patient, and ſtrengthen the Diſeaſe. Emeticks given, that may have finiſh'd their Operation a little before the coming of the Fits, and Sudorificks towards the end of a Fit, to promote and help on the critical Sweats, are of great ſervice; and by this means the Bark may be render'd effectual in the moſt obſtinate Ague, and where the Diſeaſe would otherwiſe elude all the Phyſician's Care and Skill, and bid defiance to the Bark it ſelf, as great a Remedy as it is.

NOW from theſe Obſervations and Phænomena, may be naturally deduced the following Conſequences, which may ſerve as Principles to explain the Formation, Growth, and various Appearances of Intermitting Fevers.

1. THESE Intermittents owe their Origination and Production to a cold, ſaline, coagulated, and indigeſtible Lentor, generated in the Stomach by bad Air, cold, acid, and unripe Fruits, Meats of hard Digeſtion, and all ſuch Irregu-

Irregularitys in the uſe of the Non-naturals, as tend to promote the like ſharp, ſalt, ſlimy Cruditys and Indigeſtion.

2. The Stomach being once clogg'd and loaded with any conſiderable Quantity of this viſcid, coagulated, and indigeſted Matter, ſtill increaſing from the Continuance of the ſame Cauſes; ſome Parts of it, by the natural Heat and Efflatus in the Stomach, the attenuating diſſolving Power of the Bile mixt with it, and the Action of the muſcular Coats ſtill protruding it forward; from theſe Cauſes, I ſay, ſome Parts of the Lentor already deſcrib'd, muſt be continually forced downwards, and paſs together with a viſcid and imperfectly digeſted Chyle, into the Lacteals and chyliferous Ducts: and from hence theſe Lacteals and chyliferous Ducts being gradually obſtructed, dilated and diſtended, the Lymph which ought to paſs continually thro theſe Ducts into the Blood, will be now intercepted; and the Drain of Lymph from the Arterys into the Veins being thus interrupted, the Blood wanting this neceſſary means of cooling and diluting, muſt preſently begin to heat and rarefy; that is, a Fever muſt enſue.

3. The Blood heating and rarefying from the Cauſe here aſſign'd, its Velocity muſt at firſt be conſiderably abated, partly from the Over-fullneſs and Diſtenſion of the Veſſels, occaſion'd by the Rarefaction, and partly from the Reſiſtance it meets with in the Gaſtrick, Epiploick, Inteſtinal, and Meſenterick

Arterys: for the chyliferous Ducts and Lymphaticks being now obſtructed and diſtended, muſt neceſſarily preſs upon the capillary Arterys, in the foregoing Branches and Diviſions of them. And while the progreſſive Motion of the riſing rarefying Blood is thus check'd, retarded and diminiſh'd, there muſt from hence enſue a Senſe of cold and chilly Streamings thro all the Branchings and Ramifications of theſe obſtructed Lymphaticks, chyliferous Ducts, and Blood-Veſſels: that is, there will be a Fever, attended with Thirſt, dryneſs of the Tongue, *&c.* from the Rarefaction of the Blood and the intercepted Lymph; and a cold Fit from the diminiſh'd Velocity of the Blood, and the ſudden check it meets with in all thoſe capillary Branches of the Arterys, which are now compreſs'd and conſtipated in the manner already mention'd.

4. THIS Obſtruction of the Lymphaticks and chyliferous Ducts continuing, and conſequently the Rarefaction and expanſive Efflatus of the Blood increaſing, it muſt preſs ſtrongly upon the nervous Coats of the Arterys; and by the Force of ſuch a *Stimulus*, the elaſtick nervous *Fibrillæ* being excited into quick and ſtrong Vibrations, the Blood by this means overcoming the Reſiſtance, is driven forward with a greater Force and Impetus than before; in conſequence of which, the cold Fit muſt be follow'd with the hot burning febrifick Paroxiſm.

5. THE

5. The Heat and painful *Stimulus* of the turgid rarefy'd Blood, now acting upon the nervous and elaſtick *Fibrillæ* in the capillary Arterys and lymphatick Glands, the ſmall Lymphaticks and chyliferous Ducts in the Glands muſt be hereby ſtrongly ſqueez'd and compreſs'd, and their contain'd Chyle and Lymph forc'd out and driven forward: for while the viſcid ſaline Coagulum which obſtructed the Lacteals and Lymphaticks, is attenuated and diſſolv'd, partly by the Heat and Rarefaction of the Blood, and partly by the Bile which it carried with it from the Inteſtines, and which is now excited into Action by the Heat; by this means, I ſay, the obſtructing Matter being diſſolv'd and attenuated, will be prepar'd and diſpos'd to be diſlodg'd, and driven forward thro the chyliferous Ducts into the Blood, by the ſtrong and forcible Action of the nervous elaſtick *Fibrillæ*.

6. The chyliferous Ducts and Lymphaticks being thus clear'd and open'd, and the obſtructing viſcid Matter driven into the Blood, as a neceſſary Conſequence of the hot Fit, in the manner juſt now explain'd; the Lymph will now flow freely and plentifully from the Arterys thro the Lymphaticks and chyliferous Ducts into the Veins, as before; by which the Blood being cool'd, diluted and condenſed, a plentiful Sweat breaks out, and the vitiated Lymph which had been ſtagnating in the Lymphaticks and chyliferous Ducts,

Ducts, now passes off in the Crisis by foul Sweat and Urines: and this frees the Patient for the present, till the same Causes acting again after the same manner, the Fit returns, and every thing happens as before.

7. The space of the Intermission or periodical Return, together with the Length and Severity of the Fit, will depend upon the Nature and Circumstances of the vitiated obstructing Chyle, or morbid viscid Coagulum, as generated in the Stomach: for where this is of a very cold, fix'd, and strongly cohering sort, abounding with nitrous and urinous Salts, mix'd with an extremely viscid or tenacious slime, it will pass more slowly from the Stomach and Intestines into the Lacteals; and being there, will be retain'd longer, and require more time and greater force to be driven out and dislodg'd: but where the vitiated indigested Matter is of a looser Cohesion, and abounds with Bile, and such-like warm and more active Principles, it will pass faster from the Stomach and Intestines to the Lacteals, and be more easily driven forward, when it has there produced an Obstruction or Dilatation, and raised a Fit; that is, both the Fits and their Intermissions will be shortned: And this is the difference with respect to their Rise and Progress, Generation and Growth, between Quartan and Tertian, or Quotidian Agues.

8. When the viscid slimy saline Coagulum, with which the Lacteals and chyliferous Ducts

Ducts have been obſtructed and dilated, is perfectly clear'd off from the Glands, and thrown into the Blood, by the contractive Power of the Nerves in the febrile Paroxiſm; and afterwards diſcharg'd in the critical Evacuations by Sweat and Urine; a complete and perfect Intermiſſion enſues, and all the Symptoms diſappear till the next Return of the Fit. In which caſe, a certain Number of theſe Fits, by cleanſing the Stomach, depurating the Serum, and throwing off the indigeſted Viſciditys of the Chyle, relieves the obſtructed Glands, completes the Purification of the Blood, and leaves the Perſon in a ſound and perfect State of Health; and this by the Wiſdom and Providence of Nature only, without any aid or aſſiſtance from Art and Medicine.

It may be proper therefore to obſerve here, that Spring Agues, by which the congeſted Viſciditys collected in the preceding Winter, are frequently thrown off by the wiſe Proviſion and good Conduct of Nature it ſelf; and which are not likely, by reaſon of the enſuing Heat of the Seaſon, to ſink the Blood into any great degree of Condenſation; need not conſequently be much tamper'd with by Medicine: and indeed, in this Caſe, unleſs the Phyſician be very prudent, 'tis a thouſand to one if he does not do more harm than good. For this I take to be a certain Rule, that where the Deſign of Nature is obvious, and the Intention right,

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ſhe ought not to be too haſtily interrupted, by a fooliſhly indulgent and over-officious Care; and he who offers her his Service before 'tis needed, is in a fair way of making work for himſelf, or for ſome body elſe that is wiſer.

But Autumnal Agues, eſpecially ſuch as come on in *Auguſt* or *September*, upon a plentiful fall of Rains, after great preceding Heats and a ſcorching Seaſon; and generally all Agues at any time of the Year attacking weak and languid People under ſcorbutick, hypocondriacal or hectical Habits, ought carefully to be obſerv'd, and taken off as ſoon as poſſible: for under any of theſe Circumſtances, where the general Conſtitution of the Air, or the antecedent morbifick State of the Perſon affected, conſpire with the Diſeaſe, and tend to throw off the Serum plentifully upon the Glands and Lymphaticks, which were too much clogg'd and loaded before, Nature will certainly want help; and they who in ſuch Caſes are too ſecure, and truſt themſelves accordingly to the Conduct of Nature only, will ſoon be ſenſibly convinc'd of their Miſtake: The Reaſon of which different Event of Agues at the different Seaſons of the Year, and under the different antecedent Conſtitutions of the Perſon affected, muſt be too plain from what has been ſaid, to need any farther or more particular account of it.

9. Every

9. EVERY body knows that Agues often loſe their Intermiſſions or diſtinct Periods, and exchange their peculiar Symptoms and Appearances for thoſe of continual Fevers, which are then generally, if not always of the influent, lymphatick, and condenſative Kind: for where the indigeſted Chyle and glandular Viſcidity's clear'd off into the Blood by the Paroxiſm, or where the critical Sweats have not been large or laſting enough to eject and throw off the vitiated corrupt Serum, 'tis plain the Fever muſt hereby become continual, or remitting only; and Nature in this Caſe having no leiſure Hours, muſt be oblig'd to ply her work inceſſantly, till ſuch time as the Diſeaſe can be ſubdu'd.

BUT Agues of an ill ſort, or ſuch as have not been rightly manag'd, if they do not run into ſome acute continual Fever, very often leave a ſcorbutick Taint upon the Glands, and paſs into ſome morbifick chronick Conſtitution equally dangerous, if not timely prevented. For all the hypocondriack and hyſterick Maladys, the Gout, Stone, Dropſy, *Phthiſis*, Aſthma, and in general all the various Shapes and Appearances of the ſcorbutick Conſtitution, as deſcribed *Prop.* 13. may proceed from ſuch a glutinous indigeſted Matter, according to the various Parts affected, or the particular glandular Organs upon which it is thrown, and where it happens to be lodg'd and retain'd: 'Tis true, indeed, the ſame morbid State of the Chyle

and Serum, will have the same Effects, whether an Ague has preceded or not; which having been consider'd and explain'd already at *Prop.* 13. I need no longer insist on it here.

The Method of Cure in Agues by the use of the Bark, is now so commonly known, and universally practis'd, that it would be needless to repeat here what so many have already said about it: I shall content my self therefore, with only making some general Observations concerning the Nature and Operation of this celebrated Drug, so far as its Effects depend upon any of its manifest Propertys or sensible Qualitys; and beyond this it would be in vain to search, since the finest and most plausible Hypotheses can signify but very little, where they are not evidently built upon plain Facts.

The Peruvian Bark, therefore, is most remarkably attenuating, absorbent, and astringent; which Propertys it possesses under such an equal Degree and Contemperature of *Heat* and *Cold*, that it does not discover any prevalency of the one above the other: for tho it may occasionally and consequentially, on the account of other Circumstances, as we shall see afterwards, produce the different and contrary Effects of heating and cooling, rarefying and condensing; yet in it self it is perfectly temperate with respect to those Qualitys, and neither heats nor cools, rarefys nor condenses the Blood and Humours: that is,

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it does not act at all immediately and directly upon the expansive Elements of Fire and Air, but exerts its peculiar Power and Efficacy upon the gross Substances of Water, Oil, Salts, Earth, *&c.*

THE attenuating dissolving Power of the Bark, is evident from all the Experiments made upon it; and particularly a strong Decoction of it mix'd with Blood fresh drawn in a Porringer, will keep up its Fluidity, and prevent its Coagulation longer than any thing else hitherto known or discover'd; and by the same means, the Serum is kept from coagulating in a much greater degree of Heat than would otherwise presently turn it into a Gelly.

THIS attenuating dissolving Power of the Bark is plainly owing to the strong corpuscular Attraction of its Particles; from whence it comes about, that when it is convey'd to and mix'd with any viscid Coagula, or Concretions of the Chyle or Serum in the Stomach, Intestines, and glandular, chyliferous, and Lympheducts, by attracting the small Parts of those viscid Concretions more strongly than they are attracted to each other; the concreted cohering Parts of such viscid Coagula, must necessarily be separated, dissolv'd, attenuated, and unite minutely and intimately with the Parts of the Bark, by which they are attracted and strongly retain'd: and consequently the dividing, dissolving, attenuating, and absorbing Propertys of the Cortex, are

are plainly but different Effects from the ſame Cauſe, *viz.* the ſtrong and potent corpuſcular Attraction of its conſtituent Parts.

THE viſcid Coagulums, and ſlimy ſaline Concretions of the Chyle, Lymph and Serum, being thus attenuated, attracted, and retain'd by the Bark, the ſame wonderful Drug, by its conſtringing ſtimulating Power upon the nervous elaſtick *Fibrillæ* and muſcular Coats of the Veſſels, brings them to a ſtrong and vigorous muſcular Action; and by exciting and ſtrengthning their contractive reſtitutive Forces, promotes and carrys on the Protruſion and Expulſion of the morbid Matter, which had been antecedently diſpos'd and prepar'd for Secretion and Expurgation, in the manner and by the means juſt now mention'd.

FROM this diſſolving attenuating Power of the Bark upon the Fluids, join'd with its conſtringing ſtimulating Force upon the Solids, under an exact Adjuſtment and equal Temperature of Heat and Cold, all its Effects may be evidently explain'd and accounted for: And if any thing elſe could be found out, endued with the ſame manifeſt Propertys or ſenſible Qualitys, there can be no great doubt but it would have the ſame ſenſible Effects with the Bark it ſelf. Indeed the ſame Conſtringency and *Stimulus* upon the Solids, even to a much greater degree, if requiſite, might be obtain'd from many other things that are very well known; but the ſame diſ-

ſolving attenuating Power upon the Chyle and Lymph, without over-heating and rarefying the Blood and Humours at the ſame time, cannot be effected by any thing hitherto known or diſcover'd beſides the Bark: and herein, I think, plainly conſiſts its peculiar Efficacy and diſtinguiſhing Characteriſtick in the Cure of Fevers.

THE coagulated indigeſted Viſciditys in the Stomach, Inteſtines, and chyliferous Ducts, being thus attenuated, attracted, retain'd and thrown off by the Bark, as aforeſaid; the natural Digeſtion hereby recover'd, and free Communication of the Chyle and Lymph from the Stomach and Arterys into the Veins reſtor'd; the Fever hereupon ceaſes: and by this means the Bark becomes conſequentially and in its Effects, a great and ſovereign Cooler and Diluter of the Blood.

IN weak, low, and languid Conſtitutions, where the Appetite is loſt, the Digeſtion vitiated and deprav'd, the Pulſe ſunk, and the natural Heat exceedingly diminiſh'd, from the Weakneſs of the Stomach and Inteſtines, the Relaxation of their Coats, and the Loſs or Diminution of their muſcular elaſtick Force; the Bark is the greateſt and moſt efficacious Stomachick in the World. In which Caſe the Bark, by its attenuating diſſolving Power upon the indigeſted Viſciditys, and conſtringing Force upon the Solids, corrects and reſtores the Digeſtion, contracts, ſtrengthens, and braces the muſcular elaſtick Fibres; and by

ſending a ſufficient Quantity of well digeſted Chyle into the Blood, recovers the natural Heat, raiſes a low and languid Pulſe, and ſtrengthens, warms, enlivens and invigorates the whole animal Frame.

'Tis manifeſt from what has been ſaid, that both theſe Effects of the Bark, in ſuppreſſing and ſinking the natural Heat when it runs too high, and raiſing and recovering it when it retires, languiſhes, and ſinks too low, are conſequential only, and owing to its attenuating, diſſolving, and conſtringing Powers; while in it ſelf it is neither ſenſibly heating nor cooling, but perfectly temperate with reſpect to theſe Qualitys. That the Bark has occaſionally, and under different Circumſtances, both theſe contrary Effects of heating and rarefying, and cooling and condenſing, every body knows; but that the ſame thing ſhould be naturally, directly, and in it ſelf, endu'd with ſuch perfectly oppoſite and contrary Qualitys, is plainly impoſſible: and therefore where either of theſe Intentions come in view, beyond what can be obtain'd conſequentially from the Bark it ſelf, in the manner already explain'd, we are oblig'd to render it more heating or cooling, by the due Compoſition and Mixture of other Ingredients, as the Caſe requires. For Inſtance; in the Intermiſſions or Remiſſions of low glandular and condenſative Fevers, the Efficacy of the Bark is much raiſed and improv'd by *Virginian* Snakeroot, Saffron, Cochineal, and ſuch-like warm Alexipharmicks, which well-tim'd and proportion'd, will

will enable us to diffuſe the natural Heat, bring out the critical Sweats, and procure a good Solution and Criſis; which otherwiſe could not be obtain'd by the Bark alone. But on the other hand, in the Intermiſſions or Remiſſions of Effluent, Inflammatory, and highly Rarefactive Fevers, the *Teſtacea*, fix'd Salts, and Acids, ought to be join'd with the Bark; or ſuch cooling diluting Liquors impregnated with theſe, as may haſten the Condenſation and Solution of the Blood, and bring on a timely Criſis; which otherwiſe might be too long protracted, to the great Hazard of the Patient, and Diſreputation of the Phyſician.

THERE are two Inconveniencys upon contrary Extremes, which frequently attend the uſe of the Bark in different Conſtitutions: For in ſome it will purge, and run off ſo faſt as to take no Effect; and in others it conſtipates and ſhuts up the Bowels, ſo as to hinder all natural Evacuation by Stool, and bring on an obſtinate Coſtiveneſs. Both theſe Extremes may prove very prejudicial, and are therefore carefully to be guarded againſt in the uſe of the Bark. The Inconveniencys of an over-Purgation in this Caſe are commonly known, and accordingly provided againſt: but the Error on the other Extreme is not ſufficiently adverted to, tho it is equally prejudicial, at leaſt, and for the moſt part of worſe Conſequence. For after the Bark has attenuated, attracted, and imbib'd

as much of the indigeſtible coagulated Viſcidity's as it is capable of, it is certainly of no farther uſe to be retain'd in the Body, but requires a ſpeedy Ejectment; which if it be not done by Nature, ought to be procur'd by Art: and by this means there will be way made for continual freſh Supplys of the ſame Medicine, till the remaining Parts of the indigeſted Lentor be attenuated, diſſolv'd, imbib'd, and carry'd off after the ſame manner. And indeed a Diarrhæa, which comes on purely upon the uſe of the Bark, is not preſently to be ſtop'd, but only to be check'd, reſtrain'd, and kept within ſome moderate Bounds: And if nothing be done, ſuch a Purgation generally goes off of it ſelf in a Day or two, or becomes ſo moderate as not to exceed two, three, or four Stools in 24 Hours; with which, tho it ſhould continue, the repeated Doſes of the Cortex at the uſual Intervals will ſucceed very well, and throw off the Diſeaſe with greater Expedition and Safety than if there were a long continu'd Coſtiveneſs, or a Stool but once in two or three Days: nay, in all great Oppreſſions and hot inflammatory Inflations of the Breaſt and Lungs, ſuch a Diſcharge as this laſt mention'd ought to be procur'd, if need be, by adding Rhubarb to the Bark, or ſomething of like Nature, moderately cooling and opening; and if the Pulſe be at the ſame time too low, the difficulty of Breathing great, and the Fever throws it ſelf upon the glandular

Organs of the Abdomen, the *Serpentaria*, *Contrayerva*, Saffron, or the like, may be added to the Bark, notwithſtanding the Rhubard and Openers: for tho theſe may ſeem to be contrary Intentions, yet they may very well be obtain'd together, as I have conſtantly found by Experience. And this method of moderate Purging, while a breathing Sweat is at the ſame time kept up by proper Alexipharmicks, is the ſureſt and ſhorteſt way of proceeding in all low, depreſſing, glandular, or condenſative Fevers, where the Patient's ſtrength will bear it, and the Diſeaſe is not highly contagious, or directly peſtilential.

The contrary Practice, I preſume, has ſometimes obtain'd, upon a wrong Hypotheſis, that the Bark can never be too long retain'd in the Body, or be convey'd in too great Quantitys thro the Lacteals and chyliferous Ducts into the Blood: but whether this wonderful concoctive Diſſolvent be of any uſe in the Blood or no, after it has ſpent its Force, and perform'd its attenuating, diſſolving, and abſorbing Offices in the firſt Paſſages; or whether it has any ſuch Power of attenuating, diſſolving, and carrying off the Coagula, and viſcid Concretions in the other Glands, or is capable of paſſing ſo far, may very well be doubted, at leaſt, if not clearly and poſitively deny'd. For my own part, I ſhall freely declare it as my Opinion, that the Bark exerts its chief, if not its ſole Efficacy and Dominion in the great concoctive

Gland; by which I underſtand the Stomach and Inteſtines, with their proper Secretorys, the Lacteals and chyliferous Ducts. For in the firſt place, after this Medicine has ſpent its force in the Stomach, Inteſtines, and chyliferous Ducts, by diſſolving, attracting, and retaining as much of the indigeſted Viſciditys as it is capable of, and is at laſt arrived into the Blood, there ſeems to be no uſe for it there, but to be thrown off by the natural Secretion of Sweat or Urine, together with thoſe indigeſted viſcid Impuritys which it had attracted and retain'd, and with which it had been clogg'd and ſaturated in its Paſſage; at leaſt, it cannot be imagin'd, that a Subſtance ſo ſtrongly attractive and retentive of Viſciditys, when it has been thorowly fated with ſuch as it muſt have attracted and imbib'd in the firſt Paſſages, ſhould after this be diſpos'd to enter the more remote Glands, ſo as to be capable of diſſolving the congeſted Lentor and Viſciditys there.

Besides, had the Bark any ſuch attenuating, diſſolving, and diſcuſſive Power upon the more remote Glands, as it is found to have upon the great concoctive Gland and firſt Paſſages, it muſt be capable of diſcuſſing and reſolving the Tumors and viſcid Secretions of the Bronchials, hepatick, ſplenick, pancreatick, and renal Glands; that is, it would be as general and effectual an Antiſcorbutick, as it is an Antifebrifick: but Experience has never confirm'd any ſuch uſe of it;

it; and whoever makes the Trial with such an Intention, will find himself disappointed. That the Bark has a mighty Force and Efficacy in the primary digestive Glands, *viz.* the Stomach, Intestines, and chyliferous Ducts, is very well known and sufficiently confirm'd by Experience; and this I take to be the natural Bounds and Limits of its Empire and Dominion, beyond which this great concoctive Dissolvent has little or no Effect: And indeed, it may be taken as a general and certain Rule in Practice, that things which exert their principal Efficacy upon the first Passages, ought not to be carried farther, or depended on in the more remote glandular Recesses; but are to be prudentially thrown off with all convenient speed, by Stools, Sweat, or Urine. Whatever is intended to work upon the remote Glands, ought to be carefully guarded; and its Force and Efficacy taken off upon the first Passages, by volatile oily Salts and Opiates, till it arrives at the principal Seat and proper Centre of its design-ed Agency: and this Intention might more effectually be obtain'd, by conveying the appropriated Medicines into the Blood, without passing them thro the Stomach, Intestines, and chyliferous Ducts; that is, by the means of Washes, Perfusions, Baths, and Unctions: a Practice much in use among the Ancients, and still retain'd by the more barbarous Nations; and for this Reason only, perhaps, left off, and thrown out in politer and more

civiliz'd Countrys, where Phyſicians are more numerous, Eaſe and Luxury more abounding, and Health much ſcarcer and dearer. But whether this Method be likely to be approv'd or not, one thing I am ſure of, that herein lies the great Secret of Alteratives, which by a more proper and ſignificant Name might be call'd glandular Diſſolvents, Cleanſers and Catharticks.

But to return, after the Fits of an Intermitting Fever have been put off by giving the Bark in Subſtance, as uſual, and its Ejection by Stool promoted, by keeping up the natural Evacuation at leaſt once in 24 Hours; the moſt ſure and effectual way, is to drink the Infuſion in White Wine twice a Day, Mornings and Afternoons, for three Weeks together: and for the poorer ſort of People, who cannot bear the Expence of White Wine, it may be infus'd in Cyder, or even in common Small or Table Beer. The Bark in its groſs Subſtance being very cohering, and ſtrongly attractive of its Parts one upon another, is not much adapted for Digeſtion and Chylification to paſs into the Blood: and therefore the viſcid Concretions and indigeſted Cruditys of the Stomach and Inteſtines, having been firſt attenuated, attracted and ejected, the finer and ſubtiler Parts of it will much more eaſily paſs the Lacteals and chyliferous Ducts, together with the fluid Menſtruum in which it is diſſolv'd: by which means, the remaining Viſciditys lodged in theſe Lacteals and

and chyliferous Ducts, will be diſſolved, attracted, and waſh'd out into the Blood, and afterwards thrown off by the critical Diſcharges; and hereby the Return of the Fits in Intermittents will be much better prevented, than by continuing the Bark in Subſtance, or giving it in groſs at the Interval of ſeven or eight Days, as any one will find by Experience upon Trial.

EXPERIENCE has taught us not to give the Bark in a febrifick Paroxiſm; and every body knows that when it is thus given, the Fit will be thereby protracted and ſtrengthned; which in highly inflammatory and rarefactive Fevers eſpecially, is very dangerous: The Reaſon of which is, that while the Stomach is extremely heated, and the Air contain'd in it forcibly rarefy'd, every thing admitted into it muſt preſently rarefy and run into a *Flatus*, by the expanſive Force of the heated rarefy'd Air. But the Bark being ſtrongly conſtringing and ſtimulating, when it is thus over-heated and rarefy'd in the Stomach and firſt Paſſages, muſt forcibly vellicate the nervous Coats and elaſtick *Fibrillæ*, and render their Action more intenſe and ſtrong; and this muſt raiſe the Heat, and increaſe the Rarefaction and Efflatus of the Blood and Humours, which were too high and intenſe before: And beſides, while the Bark is in this hot, rarefy'd, flatulent State, it cannot attract, abſorb, and retain the febrifick Viſciditys, and indigeſted Lentor of the firſt Paſſages,

ſages, as being reſiſted by the contrary Action of the expanſive Elements; and therefore under ſuch Circumſtances it cannot perform its proper Action, and conſequently can do no good, but muſt neceſſarily do hurt.

THE Bark being the principal Remedy now in uſe for the Cure of Fevers, and perhaps the beſt that can ever be expected, I have made theſe practical Obſervations concerning it, not for the *Adepti*, from whom I ſhall be always ready to receive Inſtruction, but for the ſake of younger and leſs experienc'd Phyſicians; that underſtanding its true and proper Operation and Efficacy, and what may or may not be expected from it, they might form their Judgments of it, and direct their Practice upon it accordingly.

SCHOLIUM I.

FROM the foregoing Theory of Fevers, it may be proper to obſerve here, the mutual Relation, Connexion, and frequent Reciprocation, between the arterial, rarefactive, and lymphatick glandular Kind; for by ſhifting the Scene from one to the other, Nature frequently endeavours to relieve her ſelf under the contrary extremes, and to gain a breathing time by the alternate Rarefactions and Condenſations of the vital Fluid, till the Blood can be reſtor'd to its natural State, and ſettled in its original ſalutary Conſtitution.

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ANY occaſional inflammatory Heat and Rarefaction raiſed in the Blood, however brought on, muſt, by thickning the Serum, expanding and enlarging the Blood-Globules, and cloſely uniting the *Craſſamentum* with the Lymph, diminiſh and interrupt the glandular Secretions; and this cooling diluting drain of Lymph from the Arterys into the Veins, being obſtructed and intercepted, the Heat and Rarefaction of the Blood muſt ſtill increaſe, till the Blood-Veſſels having acquir'd a Plethora and immoderate Fullneſs, partly from the Heat, Rarefaction, and Efflatus of the Blood, and partly from the continual drinking, and pouring in of freſh Liquors, occaſion'd and as it were neceſſitated by the Heat and Thirſt; from which Plethora, the Impetus of the Blood being checkt, reſtrain'd, and its Velocity diminiſh'd by the great Reſiſtance, it will be diſpos'd to condenſe, and throw off its Serum again upon the Glands and Lymphaticks: but this Condenſation is very often too precipitate, quick and ſudden, and throws a greater Quantity of Serum upon the Glands and Lymphaticks, than can eaſily be diſcharg'd and got off again; in which Caſe the Fever ſeems to change its Species and Appearances, and from Effluent, Arterial and Inflammatory, becomes Influent, Lymphatick, and Condenſative; till this ſurcharge of Serum upon the Glands and Lymphaticks, by obſtructing and intercepting the Circulation of the Lymph, and tumefy-

ing and distending the Glands, acts powerfully as a *Stimulus* upon the nervous muscular Coats of the Arterys, and by that means throws out the Fever, and raises the Pulse and inflammatory Heat again. In which alternate Course, Nature endeavours as it were by shifting Hands, and throwing the Burden from one side to the other, to gain some Relief and Time, till a salutary Crisis can be procur'd, and the vitiated tainted Serum pass'd off by the critical Discharges: but tho the Intention be here perfectly right, and the Structure of the Machine wonderfully contrived to obtain it, yet Nature it self thus oppress'd, and under such Confusion, often either over or under-does the Work; and therefore it is the Business of a Physician, carefully to watch these Reciprocations in Fevers, to regard the Intention of Nature in them, and to keep up the Balance, by throwing the Weight on one side or the other, and this with a steady and wary Hand, till such time as a proper Crisis can be procur'd. How this may be done, must be very obvious from what has been already observ'd and consider'd, under the foregoing Account and Theory of Fevers; and they who are a little acquainted with the Conduct of Nature in this Case, will not wonder that the same Fever should often shift its Appearances and Symptoms, so as to require alternately a different Method and Process in the Physician, as much as any two different and contrary Fevers.

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SCHOLIUM II.

BLISTERING has been found by Experience to be of ſuch wonderful and extenſive uſe in Fevers, and is now ſo generally receiv'd and practis'd by the beſt and ableſt Phyſicians, that it may be worth while here to conſider theſe Epiſpaſticks in their Effects and manner of Operation a little more diſtinctly; the way of applying and dreſſing them, and their outward ſenſible Appearances in raiſing the Skin into large Bladders, and drawing off conſiderable Quantitys of a hot, ſharp, and ſalt Serum from the glandulous and fleſhy Parts of the Body, are ſo commonly known as to need no particular Account or Deſcription here: but the mighty change and turn upon the Symptoms which they induce when they are timely apply'd in Fevers, is ſo very great and remarkable, that I ſhall firſt recount the main Particulars, and then endeavour in ſhort to explain the Ground and Reaſon of their principal Operation and ſenſible Effects.

1. THEY raiſe and ſtrengthen a low trembling Pulſe, and powerfully derive the natural Heat and Efflatus of the Blood outward; by which means they take off thoſe convulſive Twitchings and ſpaſmodick Contractions of the extreme Parts, which commonly attend low lymphatick Fevers: and by the ſame means they ſecure the Bowels, with the glandular and muſcular Organs contain'd in

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the Thorax and Abdomen, from Inflammatory Tumors, Mortification, and Gangreens, which must otherwise very often be the Consequence of a too great and forcible Afflux of the hot rarefy'd Blood and Serum inward upon those Organs.

2. THESE Epispasticks speedily and wonderfully give Relief, in all those delirious Ravings, soporiferous Stupors, and loss of Reason, Judgment and Memory, which are the common and well-known Symptoms of high and dangerous Fevers.

3. THEY reduce, in a short time, continual Fevers to such plain, regular, and distinct Remissions, as to make way for the use of the Bark; and consequently for a perfect Cure and safe Solution of the Fever.

4. THEY cleanse and open the obstructed tumefy'd Glands and Lymphaticks, bring on kindly and safely the critical Sweats, let loose the Saliva and glandular Secretions of the Mouth and Throat, and bring down the thick, soluble, and critical Urines; by which means they are extremely cooling, moistening and diluting, in their Effects upon the Blood and Glands in general, how hot and fiery soever they are in themselves.

THESE are the common and well-known Effects of Cantharides, when apply'd in Plaisters to the outward Skin: but how such an extremely hot, and perfectly caustick Insect, should so mightily cool and dilute the Blood in Fevers, may be thought somewhat strange; which

which yet may perhaps be eaſily enough accounted for, after the following manner.

THE Cantharides or *Spaniſh* Flys, with which Bliſters are rais'd, are plentifully ſtock'd, as is well known, with a very hot, ſubtile, active, and extremely pungent Salt; a conſiderable Quantity of which entering the Blood upon the Application of Epiſpaſticks, is there ſtrongly attracted by the Serum, and paſſes together with it thro the ſeveral glandular Strainers and ſecretory Ducts.

THIS Property of the Cantharides, or their finer and moſt active Salts, in mixing and intimately uniting with the Serum, and paſſing off with it in the ſeveral Secretions, is very plain and obvious in Fact: and the Urine being a large Drain of Serum, in which a great Quantity paſſes off thro a few ſmall Pipes, the heating ſtimulating Power of the Cantharides is moſt ſenſibly felt here, ſo as frequently upon the Application of Epiſpaſticks, to occaſion Strangurys and Bloody Urine; which is yet eaſily prevented, or ſoon taken off, by drinking freely of ſome cooling milky Diluter, ſuch as Milk and Water, Milk-Porridge, or eſpecially a thin Emulſion made with the Pulp of roaſted Apples in Milk and Water.

BUT tho the heating ſtimulating Force of the Cantharides, is moſt ſenſible upon the urinary Diſcharges, for the Reaſon already given, yet from the liberal, foul, and ſtinking Sweats which theſe Epiſpaſticks generally bring

bring on, 'tis plain that they cleanſe and ſcour the cutaneous Glands likewiſe: and indeed, ſince the Serum can have no elective Power upon theſe Salts, 'tis plain that equally uniting with the Lymph or Serum, they muſt proportionally paſs with it thro all the Lymphaticks, and glandular, ſtraining, and conveying Pipes univerſally.

Upon this Suppoſition, which is ſufficiently evident in Fact, and from the Reaſon of the thing, we may conclude, that the ſubtile penetrating Salts, and volatile pungent Parts of which the Cantharides conſiſt, being carried into the Blood upon the Application of theſe Epiſpaſticks, and paſſing with the Lymph or Serum into the glandular ſtraining and conveying Pipes, act there by diſſolving, attenuating, and rarefying the viſcid Coheſions of the Lymph and Serum; and by ſtimulating the nervous Coats of the Veſſels throw off their ſtagnating Viſcidity's; and by cleanſing the Glands and throwing off their coagulated concreted Lymph or Serum, reſtore the Circulation and free Drain of Lymph from the Artery's to the Veins; and at the ſame time, by opening, ſcouring, and cleanſing the expurgatory Glands, bring on the critical Sweats and Urines. And by this means 'tis evident, that theſe extremely ſubtile, active, and pungent Salts derived from the Cantharides, purge the Glands and Lymphaticks univerſally, much after the ſame manner that common Catharticks do the Guts:

Guts: For as the common Cathartick or Purgative Medicines, by heating, rarefying, and diſſolving the viſcid Coheſions of the Fluids, and ſtimulating the Solids, cleanſe and throw off their clammy, ſtagnating, and obſtructing Contents; ſo theſe hot, active, and ſtimulating Salts of the Cantharides, being endued with the ſame Propertys, and capable of penetrating the whole animal Machine, are hereby fitted for a glandular lymphatick Purge, and to perform the ſame thing in the glandular, ſtraining, and conveying Pipes univerſally, that the common Catharticks and Purgatives effect in the Inteſtines: and as this ſort of Purgation reſtores the Circulation of the Lymph, and opens all the Sluices and Out-lets of the glandular Secretions, the Cantharides muſt in conſequence be wonderfully cooling, diluting, and refrigerating in their Effects, as we find they are in Fact, how hot, cauſtick, and pungent ſoever they are in themſelves.

The Quantity of Serum diſcharg'd by Bliſtering, is ſo very ſmall in proportion, that the great Effects of Epiſpaſticks cannot poſſibly be owing to this; ſince five times the Quantity brought off by Bleeding, Vomiting, Purging, or any other Evacuation, would have no ſuch Effects: and indeed, we ſee Epiſpaſticks frequently attended with very great and extraordinary Effects, where they ſcarce raiſe any Bliſters at all, and where the Quantity diſcharg'd is very little, or next to no-

thing: and therefore, tho ſome conſiderable Relief may often be obtain'd by an immediate Epiſpaſtick Drain of the congeſted viſcid Serum from ſome particular tumefy'd Glands, yet we muſt conclude the great and general good Conſequences of them, as above, to be owing to their heating, attenuating, pungent Salts, mixing with the Serum of the Blood, and acting as a lymphatick Purgative, or glandular Cathartick, as before explain'd.

FROM this account of the Nature and Operation of Epiſpaſticks, 'tis evident that their principal uſe is in Lymphatick Influent Fevers, or ſuch as are commonly call'd Depreſſing and Nervous: but in Effluent and highly Rarefactive Fevers, where the Pulſe is ſtrong, and the external Heat and Efflatus very great, Epiſpaſticks are not to be apply'd, till Bleeding in ſufficient Quantitys has preceded; leſt by increaſing the Velocity and effluent Impetus of the Blood, too great before, the Purples ſhould be forced out, and general Mortification of the Fleſh enſue. But after the Velocity, diffuſive Impetus, and Efflatus of the Blood, have been ſufficiently moderated and reſtrain'd by Bleeding, the Application of Epiſpaſticks will be of great uſe, to prevent the Fever from changing its Species, and turning inward upon the Bowels; as it frequently happens where the Velocity and Efflatus of the Blood have been ſuddenly check'd by large Bleeding, and no due Care taken afterward to keep up and diffuſe

fuſe the natural Heat, till a proper Criſis can be obtain'd.

In all delirious Ravings, and ſoporiferous Stupors, attended with Convulſions and Spaſms, Bliſtering the Head is moſt effectual, and gives the moſt certain and ſpeedy Relief. I generally apply a large Epiſpaſtick to the whole hinder part of the Head, to come up ſo far as the Crown, like a backward Cap or Coif; which in this Caſe often procures a ſpeedy and ſafe turn to the Diſeaſe, and takes off the moſt dangerous and threatning Symptoms, after ſix or eight Epiſpaſticks apply'd to other Parts have had no effect.

When upon the Application of Epiſpaſticks, the Skin and Fleſh under them are but little, or not at all changed from the natural State and Colour, and preſently become pale and dry, like the other Fleſh; this may be look'd upon as a mortal Symptom: nor have I ever known any one recover after ſuch an Appearance; for this plainly indicates the retiring of the Animal Life and Motion to the Centre, while the Blood ſtagnates outwardly, and leaves the extreme Parts almoſt in the Condition of a dead Corpſe.

SCHOLIUM III.

Having mention'd Blood-letting in Fevers, and this Practice generally prevailing in all Fevers without diſtinction, it may not be amiſs here to make ſome farther Obſervations concerning it, and to ſhew as briefly

and clearly as I can, what may or may not be expected from it. I need not describe the Operation it self, or the manner how it is done, since that is sufficiently known to every body; but when a Blood-Vessel is cut, and the Blood by means of a Ligature oblig'd to run freely out at the Orifice, the Consequences will be chiefly these which follow.

1. SINCE the Blood flows thro the Orifice without Resistance, or not being at all impeded by the antecedent Blood, 'tis manifest the Velocity of the Blood at the Orifice will be increas'd: that is, a greater Quantity of Blood will flow thro the Orifice in a time given, than could have circulated thro the Vessel during the same time in its natural State.

2. THIS Augmentation of Velocity will be greatest at the Orifice it self, where the Blood meets with no Resistance at all; and so proportionally in the Vessels which communicate immediately with that in which the Orifice is made, while the remoter Vessels will be less drain'd and empty'd by it, in proportion to their distance from the Section: for the Blood in these, finding a free Passage to and from the Heart, thro such Branches and Divisions of the Vessels as are very remote from the Orifice, is not much affected by it, but continues its Circulation as before.

3. THE same Quantity of Blood will be deriv'd from the Heart in the same time, during its efflux from the Orifice, as before:

for as the Velocity at the Orifice is augmented in proportion to the Reſiſtance taken off, ſo 'tis evident that the Protruſion of the Blood forward, is likewiſe taken off by the Ligature in the ſame proportion; and therefore the Velocity and *Momentum* of the Blood at the Heart, being leſſen'd by one of theſe, as much as it is augmented by the other, it muſt continue the ſame: but this muſt be underſtood only of ordinary Bloodletting, while the elaſtick Spring of the Veſſels, and a ſufficient Quantity of the Fluid, are retain'd and kept up. For in caſe the Bleeding be continu'd ſo long till the Springs and Principles of Motion ſink and fail, 'tis evident that the Quantity of Blood derived from the Heart, and ſent thither in the ſame time, muſt ſtill diminiſh, and at laſt end in a perfect Stagnation. And this muſt alſo limit the Senſe of what has been aſſerted concerning the Augmentation of Velocity at the Orifice; for this will happen only while there is a ſufficient Supply of Blood from the next communicating Canals: but when theſe are empty'd, their vaſcular Coats contracted, and the elaſtick Spring of their Fibres weaken'd, the Blood in them beginning to thicken and ſtagnate, the Velocity at the Orifice muſt diminiſh as the Reſiſtance increaſes, or as the motive Force towards the Section is leſſen'd, from the foregoing Reaſons.

4. By Blood-letting therefore, the largeſt, quickeſt, and ſtrongeſt Drain, is from the Veſſels immediately communicating with that in which the Section is made, which are firſt empty'd, while thoſe which are more remote are drain'd more ſlowly, and in a leſs Quantity and Proportion: and this might be farther confirm'd by numerous Obſervations, and Experiments too plain to be diſputed. Every body knows, that Bleeding in the Jugulars, or Temporal Veſſels, will give the moſt certain and ſpeedy Relief in any Diſeaſes of the Head, occaſion'd by a too great afflux of the Blood thither, and an immoderate Diſtenſion of the cervical and carotid Arterys in the Brain: and in any great Inflammation or extraordinary Afflux of Blood to a particular Part, Experience has generally taught the practical Phyſicians to open a Vein, as near as may be to the Part affected, as finding in Fact, that Veſſels immediately communicating with the Section, are firſt drain'd and empty'd. But to be convinced of this, we need only obſerve what happens to Animals, which bleed to death by an Efflux of Blood from different Parts of the Body: to which purpoſe let two Dogs be thus ſuffer'd to bleed, one by cutting the Jugulars, and the other by cutting the crural Veſſels; and it may be obſerved of that which bleeds from the Jugulars, that the upper and fore-Parts die firſt, while the lower and hinder-Parts will continue their Motion under ſtrong Convulſions for ſome

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conſiderable time after the upper Parts are quite dead and motionleſs: which plainly ſhews, that in this Caſe the Blood is firſt empty'd, and drain'd off from the aſcending Branches and Ramifications of the *Aorta*, in conſequence of which the Life and Motion in the upper Parts ceaſe, while the Circulation ſtill remaining in the deſcending Branches of the great Artery, the Life and Motion in the lower Parts are continu'd ſome time longer. The contrary to this will happen to the Dog which dies bleeding from the Crurals; for here the deſcending Trunk and Branches of the *Aorta*, being firſt drain'd and empty'd, the Life and Motion will be firſt loſt in theſe.

FROM hence we may ſee how much they are miſtaken who conclude from the Circulation of the Blood, that 'tis indifferent where or in what part of the Body a Blood-Veſſel be opened: for the Blood, ſay they, communicating by its Circulation, and ſtill keeping up its *Æquilibrium*, the Effect muſt be the ſame, whether a Blood-Veſſel be opened in the Head or in the Foot. But this is contrary to Fact and Experience, as well as to the Nature and Reaſon of the Thing; and may therefore be look'd upon as a wrong Conſequence from a right Principle: The Circulation of the Blood is undeniable, but this Conſequence drawn from it will never be granted, as long as there are any well-experienc'd and good practical Phyſicians in the World.

5. FROM this unequal Derivation and Evacuation of the Blood in Blood-letting, and the broken or interrupted *Æquilibrium* of the Fluid consequent hereupon, 'tis evident that the Ligature being loosed, and the Blood suffered to take its natural Course, it must presently be thrown into a strong intestine Commotion, Fluctuation and Effervescency, occasion'd by the natural and necessary Efforts of the Fluid to regain its *Æquilibrium*, and restore its former equable and uniform Circulation, after some of the Vessels have been drain'd and empty'd in a much greater proportion than others. Now when the Blood has been thrown into this new Commotion and general Confusion, what turn it will take, and what the Consequences may be, must be very uncertain and precarious, and such as the best Physician in the World can never be accountable for: the consequence of which is, that this Practice is never to be comply'd with, without some plain, apparent, and urgent Necessity, and where the same Intention cannot be safely obtain'd any other way. 'Tis possible, indeed, the Blood being put into such an intestine *Luctus* and Commotion by Bleeding, that Obstructions may be hereby removed, the Coagula and Concretions in the small Vessels dissolv'd, dislodg'd, and wash'd off, the exorbitant Efflatus and rising Tide of the vital Fluid cool'd and suppress'd; from whence great Advan-

Advantages may enſue, as we ſee in ſome Caſes by Experience.

BUT then on the other hand, this Practice in Fevers often brings on large and profuſe ſymptomatical Sweats, deep and dangerous Depreſſions, *Deliquia*, Palpitations of the Heart; and ſometimes the Fever is hereby thrown very dangerouſly inward, and fix'd ſo ſtrongly upon the Lungs and Viſcera, as afterward to admit of no Cure. For this may be taken as a certain Rule, that all Coagulations, Concretions, and viſcid Adheſions of Blood upon the ſeveral Organs, if they are not ſoon reliev'd by Blood-letting, will be the more fix'd, radicated, and confirm'd thereby: which ought to make us cautious in what Caſes and under what Circumſtances we attempt the removing Obſtructions by Bleeding, ſince this is a Method of ſuch a nature, that if it does not ſucceed, ſeldom leaves room for any other. I am ſatisfy'd, that the beſt and ableſt Phyſicians will be ready to own, that there is not a greater Difficulty in the whole Practice of Medicine, than the forming a ſure and right Judgment concerning Blood-letting, in the ſeveral Caſes, and under the various Circumſtances in which it may do good or hurt: and yet not only the general Run of Apothecarys, but abundance of young unexperienc'd Phyſicians, when they firſt ſet up their Practice, think they ought to make this a principal part of it; and accordingly try it almoſt in all Diſeaſes, eſpecially Fevers, and upon

upon all Conſtitutions: by which Raſhneſs and Precipitancy, a good hopeful Caſe is often made deplorable and altogether deſperate. Indeeed the taking off a ſmall Quantity of Blood, ten or twelve Ounces, and only for once, can neither do much good nor harm in any Caſe: and this being ſo often done upon every ſlight Occaſion, People are the more apt to believe they are the better, becauſe they do not find themſelves the worſe for it; and have hereby the Satisfaction to have prevented ſome farther Miſchief which they were never in danger of. This trifling inſignificant way of Bleeding, however, is ſo very innocent, that I cannot heartily condemn it, ſince this good at leaſt comes from it, that the Apothecary or Surgeon who performs the Operation, receives his cuſtomary Fees. But where Blood is to be drawn off in any large Quantitys, or frequently to be repeated, as is commonly the Caſe in great Exigencys; and where any conſiderable good Effects are to be expected from it, it ought to be under the Care and Direction of an able and well-grounded Phyſician: for after all, it muſt be allow'd, that there are ſome Caſes, particularly of Fevers, where Blood-letting is of urgent neceſſity, and ought not to be diſpens'd with; as,

1. In ſtrongly effluent and highly rarefactive Fevers, attended with a ſtrong turbulent Pulſe, burning Heat, delirious Ravings, and ſuch a general Outrage and Efflatus of the Blood,

Blood, as to force out the Purples, occasion bloody Secretions, and threaten an imminent Hemorrhage and Evasation of Blood upon the Brain: in this Case Blood must be taken off without delay, and that in Quantitys sufficient, as effectually to suppress the preternatural Heat, Efflatus, and Outrage of the hot, turgid, and boiling Blood. For in such an Exigence, if a sufficient Quantity be not taken off, it serves only, by exciting a greater intestine Commotion and violent Fluctuation, to render the Case much worse and more desperate than before.

2. In any great and apparent Plethora of the Blood-Vessels, by which they are overstretch'd and distended, and the elastick restitutive Force of their muscular Coats weaken'd and destroy'd; in this Case likewise Blood must be speedily taken off, and that in a sufficient Quantity to answer the Intention: for otherwise, as before, more hurt than good may ensue. And such a Case of a real Plethora in the Blood-Vessels will discover it self plain enough by its natural and necessary Symptoms, as great outward Heats, high Colour, Lassitude, lethargick Drousiness, asthmatick Suffocations, and a dull, heavy, dragging and slow Pulse.

3. In Peripneumonys, Pleurisys, and such-like Adhesions of the coagulated concreted Blood upon the principal Organs, if the Case is recent, and the Obstruction be not fix'd too deep upon the Glands, it may be reliev'd by

by Blood-letting: But in all ſuch Caſes, after the Outrage and Efflatus of the Blood are pretty well ſuppreſs'd by Bleeding, the ſafeſt way is to apply Epiſpaſticks, in ſuch a manner as to have their main Effects as much as poſſible upon the Parts chiefly affected.

4. In Apoplexies, ſome ſort of Epilepſies, and Vertigoes, and generally in all Caſes which plainly indicate a ſtrong and violent Tide or Afflux of the Blood to the Head, ſo as to threaten an Hemorrhage or Evaſation upon the Brain; a good Quantity of Blood muſt ſpeedily be taken off, ſince in ſuch an Exigence there is nothing elſe to be done, and it would be loſing the Patient to wait for the Operation of any other Remedy.

5. In extremely pungent and acute Pains, or Stitches, which ſometimes come on from a ſudden windy Efflatus of the Blood in the ſmall Veſſels, Bleeding, even in a ſmall Quantity, is of great uſe; and I have ſometimes known the Patient reliev'd upon opening a Vein almoſt as ſoon as the Blood begins to flow.

But in theſe and ſuch-like Caſes, where Bleeding is either neceſſary, or at leaſt of ſome conſiderable uſe, when well directed, it requires a nice and diſtinguiſhing Hand to adjuſt the Quantity, and to prevent the Miſchiefs which may ariſe from the taking off too little or too much of this vital Fluid; which is not therefore to be truſted to the ſlight Judgment of every one who for this purpoſe

purpoſe has provided himſelf with a Lance. I have often wonder'd at the great Practice in this way of ſome Country Barbers, who in ſmall remote Pariſhes and Villages, get more by Bleeding than by Shaving their Cuſtomers; and by which they procure a handſom Livelihood, join'd with another laudable Practice of Drawing Teeth. And that which has made the Practice ſo general, is doubtleſs an Imagination, that this is the ſhorteſt and eaſieſt way to get rid of Diſeaſes: The common People will readily adviſe themſelves, if no body elſe adviſes them, to Bleeding; who would yet never give themſelves the trouble of a little Sweating, laugh at taking a Purge, as ſoon be knock'd on the Head as ſubmit to a Vomit, and think it a piece of Cruelty but little leſs than Murder in any one, who with ever ſo much Judgment or Reaſon ſhould propoſe a Bliſter; tho any of theſe are more generally uſeful, and much leſs precarious in their Effects.

But if this Practice be often of ill Conſequence, for want of Judgment where the thing it ſelf is neceſſary or uſeful, the Miſchiefs muſt be ſtill greater, where it is advis'd and reſolv'd upon under wrong Circumſtances; and generally in all great Depreſſions and Concentrations of the Blood and Humours, in all deeply fix'd and radicated Diſeaſes, and in all ſuch Effects of a ſudden condenſing Cold, as often brings on the worſt of Fevers, Bleeding can never be adviſable, and that Patient

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is well off with it who is not a great Sufferer by it.

My Design in this Scholium will be sufficiently answer'd, if it may serve in some measure to check the Overforwardness of those who seem to look upon the Lance as a true Specifick in most Diseases, and who accordingly practise but little more than this Horse-Method, in which the Farrier certainly is generally more successful than the Physician.

I PRESUME I have said enough for the Usefulness and even Necessity of Blood-letting under a proper Care and judicious Direction, to guard against Misapprehension or Censure, from any learned or well-experienc'd Physicians; and for others, whose Interest or Humour may dispose them to quarrel, I hope they will pardon me, at least, when I have let them know, that notwithstanding any thing I have here said, they are still at liberty, as before, to shed as much innocent Blood as they please.

PROPOSITION XVI.

TO explain the natural Order, and the several morbifick Irregularitys of Digestion.

THEY who have amus'd themselves upon the chymical Principles to find an acid *Menstruum* in the Stomach, capable of dissolving the Food or Aliment, and of converting it into Chyle, have never succeeded in any such

such Attempt: and indeed the Enquiry was undertaken and prosecuted without any Foundation, since the Chymists themselves are oblig'd to own that they could never obtain any thing of an Acid from Blood or other animal Substances. 'Tis true that Acidity's are sometimes found in the Stomach and first Passages; but then they are always generated there as the morbifick Effects of a bad Digestion, and are so far from helping or promoting a regular Concoction, that they always vitiate, corrupt and pervert it. And tho Acids medicinally given, may sometimes help and promote the natural Digestion, where the Error was before on the contrary extreme, and the Concoction too hot and flatulent; yet a natural Acid in the Stomach, duly and regularly secreted by its proper Glands, is doubtless a mere Chimera, and a Creature of the Imagination only.

But without inventing groundless Hypotheses, or creating imaginary and merely suppositious Principles, 'tis evident from *Prop.* 37. *Part* I. that all Bodys universally contain within themselves the natural Principles of Dissolution; and that the elementary Fire and Air which enter into the Constitution of all the grosser material Substances, may, when they are once excited and put into Action, exert an expansive Force sufficient to attenuate, disunite, dissolve, and diffuse the Parts of the most fix'd, solid, and closely cohering Bodys in the World. Now to produce this

this Effect, that is, to excite and put into Action the elementary Fire and Air which are retain'd in the natural Texture and Conſtitution of all mix'd compound Bodys, and thereby to ſeparate, diſſolve, and diffuſe their cohering Parts, there needs nothing but a ſufficient degree of *Heat*, which is the Action of the foregoing expanſive Elements already in Motion.

To apply this to the Buſineſs of Digeſtion, it may be obſerv'd, that the vegetable and animal Subſtances made uſe of for Food and Aliment, having been firſt broken, divided, and comminuted by Maſtication, and ſoftned, lubricated, and moiſten'd with the Saliva, is protruded into the Stomach; where, meeting and mixing with the Liquors, the Maſs is farther ſoak'd, macerated, and prepar'd for Solution. Under which Circumſtances, the Stomach, by means of its muſcular Coats, contracting and compreſſing its Contents, the mix'd Maſs of Solids and Fluids is hereby retain'd and ſhut up in a cloſe digeſtive natural Heat; the congeſtible Matter being at the ſame time continually agitated, elaborated, and intimately blended together by the muſcular Force and Action of the Stomach. But here it muſt be obſerv'd, that the Orifices of the Stomach during the time of Digeſtion, are not ſo cloſely and ſtrongly ſhut up by the Contraction of their muſcular Fibres, but that they open at certain Intervals to ſuffer the vapid Fumes to paſs off, and let in freſh Air;

Air; which fresh Supplies of Air suddenly rarefying and expanding, the natural digestive Heat and Efflatus of the concocting Matter is hereby maintain'd and kept up.

THE expansive Elements naturally contain'd in all the minute divisible Parts of the concocting Matter, being thus excited and put into Motion, the Consequence of this must be a Dissolution of the solid cohering Parts, and an intimate mixing and blending them with the Fluids, by *Prop.* 37. and 38. Part I. that is, the whole Mass will be reduc'd to a sort of thin frothy Gelly, somewhat like a very soft, tender, and slightly cohering Curd: And this is the first Act of Digestion, namely, rarefactive Dissolution.

THE concoctive Matter being thus far digested in the Stomach, it is thrust forward thro the *Pylorus*, by the muscular Action of the Stomach, and empty'd into the *Duodenum* and small Guts, where it meets with the Bile and pancreatick Juice, and undergoes a second degree of Digestion or Concoction, which is next to be explain'd.

NOW the proper Action of the Bile and pancreatick Juice, is Precipitation: that is, the grosser Parts of the first Concoction in the Stomach, or such as could not admit of a perfect Solution and Digestion, are attracted and precipitated by the Bile, and thereby separated from the more fluid Parts: and the concocted Matter being thus attenuated, depurated, and freed from its Sediment or *Fæces*,

ces, is reduc'd to a thin, fluxile, white and oily Liquor, like Milk, and then receives the Name of Chyle.

THE Chyle being thus depurated, and purg'd of its groſs, excrementitious, and indigeſted Feculencys, is receiv'd into the Lacteals by corpuſcular Attractions of thoſe infinitely numerous and exceedingly minute Pipes or Strainers; and in the Lacteals and chyliferous Ducts it undergoes a farther degree of Attenuation and Dilution, by the Lymph which joins it from the numberleſs lymphatick Glands which empty themſelves into the chyliferous Ducts; and with which continu'd Current of Lymph the Chyle paſſes into the Blood.

THE Bile having attracted, precipitated, and ſeparated the groſs indigeſted Recrements of the Chyle, performs another neceſſary office in the animal Body, in order to perfect the Operation of the great concoctive Gland, which is attenuating the Feculencys of Concoction, which it had ſeparated from the Chyle, and thereby keeping the Excrements from running into too hard and dry Concretions; and at the ſame time by ſtimulating gently the Inteſtines, and promoting the muſcular vermicular Motion of their Coats, it acts as a mild congenial Cathartick; and by this means ſecures and carrys on the natural Purgation or Secretion by Stool.

Now

Now while these Operations proceed right and regular in the manner here describ'd, the Digestion is sound and good; and the primary concoctive Gland performing its office, and supplying the Blood with sufficient Quantitys of well-prepar'd Chyle, the animal Functions will be *cæteris paribus*, strong and lively, and the Animal continue in a state of Health or Rectitude. But this work of Digestion is subject to various Perturbations and Irregularitys; the principal of which it may not be amiss here to take notice of and account for.

Now the first Concoction in the Stomach, which is effected by the heating, rarefying, and dissolving Power of the expansive Elements, may be either too intense, high and strong, or too weak, low and remiss: the former is a hot and flatulent, the latter a cold and hard Digestion. And after the same manner, the consequent Depuration, and Precipitation by which the Chyle is attenuated, thinn'd and fluxiliz'd, may either be in a too high or too low degree; the one of which is a gross and feculent, the other a sharp and acrimonious Digestion: And these being the principal Errors of Digestion, I shall proceed to consider them a little more distinctly, and to shew from what Causes they are produc'd, and how to be rectify'd.

1. When the Action of the expanſive Elements, or their rarefying diſſolving Power in Concoction is too ſtrong, and exceeding the bounds of Nature, the Digeſtion will be hot and flatulent; that is, the concocted Matter, inſtead of retaining its natural and due Conſiſtence, will run into a frothy, hot, and windy Flatus: and this too highly rarefy'd Concoction, not being capable of a ſufficient Precipitation, Depuration, and Attenuation afterward, by the Bile, pancreatick Juice and Lymph, muſt continually repleniſh the Blood with an hot, rarefy'd, and viſcid Serum; and be attended with all the Conſequences of Heat, Flatulency and Viſcidity, throout the whole Machine; ſuch as immoderate Tenſion and Inflation of the Stomach and Inteſtines during the time of Digeſtion, with hot Fluſhing and ſhortneſs of Breath, ſharp and ſcalding Fumes and Belches, windy Cholicks, reſtleſs watching Nights, eſpecially after a late and plentiful Supper; periodical burning Heats, a general Indiſpoſition to ſweating, unleſs it be ſometimes low fainty Sweats; and a liableneſs to be over-heated upon any little Motion or Exerciſe; with other ſuch-like Effects of a too great Quantity of hot rarefy'd Air, pent up and retain'd in a ſlimy, viſcous, and indigeſted Serum.

This Error of Digeſtion is generally owing to Intemperance and want of Exerciſe: for very few, if any, are liable to it, but Epicures and idle Drones; who being a uſe-

leſs

leſs Generation to others, and ignorant of the manly ſerene Pleaſures of Temperance and Exerciſe, ought in all Reaſon to enjoy themſelves in ſuch Company as the foregoing Symptoms; with which they have the ſatisfaction to put a timely End to a very ſhort and painful merry Life. To preſcribe Shop Medicines here could ſignify but little, ſince the only means of Recovery are in every one's Hands; I mean, obſtinate Temperance and proper Exerciſe: they who uſe this Remedy will need no other; and ſuch as cannot comply with it are incurable. All the Phyſician can do, is to ſend them during Life twice a Year to the *Bath*; unleſs *Briſtol* be thought moſt convenient for thoſe who are more remote from it, as being a longer Journey, and where they will have the Advantage of drinking a little Water; and, I fear, too little in proportion to the Wine.

But for ſuch as, under this Error of Digeſtion, viſit the Mineral Springs only for their Health, I have one thing to adviſe them, and that is, to try before they ſet out what moderate plain Feeding and Water-drinking will do at home; to which if they add proper Exerciſe, they may perhaps ſave Money, and thank me for the Advice. But they who deſire only a few ſhort Intervals of Eaſe under a continued Courſe of Luxury and Lazineſs, which they are reſolv'd to indulge, muſt uſe their Liberty; and for which poſſibly in quality of a Phyſician I might have

ſome Reaſon to thank them: tho I think no Man of a publick Spirit would thank them, excepting only the Gentleman who writ *The Fable of the Bees.*

2. FROM a defect of natural Heat, and where the rarefying diſſolving Power of the expanſive Elements is too weak, remiſs and low, there enſues a cold and hard Digeſtion; in which only the thinner and more watry Parts of the Food are ſeparated and diſengag'd from the reſt, while the richer Oils and volatile Salts, which cohere more ſtrongly with the Solids, are left untouch'd for want of Heat and Efflatus ſufficient to ſeparate, diſſolve, and raiſe them in the Decoction. Now theſe volatile oily Salts, which in a good Digeſtion are the laſt ſeparated, are not in this Caſe ſeparated at all, but precipitated together with the *Fæces* down the Guts, and ejected by Stools; while nothing is carried into the Blood but the thin watry Parts, with ſuch few Salts as will moſt eaſily riſe and unite with the Water. In this morbifick ſtate of Digeſtion, the volatile oily Salts which ought to paſs into the Blood, and be attracted into the Globules, being left undiſſolved in the Concoction, and precipitated with the Excrements, the Blood hereupon, for want of this Supply, runs immoderately into Serum, and loſes its due Quantity and Proportion of *Craſſamentum*; upon which the Pulſe becomes weak and low, the natural Heat ſinks, the nervous

elaſtick

elaſtick Fibres and Springs of Motion grow weak, ſoft and flabby, the Perſon is dull, liſtleſs, and averſe to Motion; and all the animal Powers, as it were fatigu'd and jaded, droop, languiſh, and decline their work: and the Blood being thus deprived of its richer Oils and volatile Salts, it will be carried to the Liver too much abounding with Serum; in conſequence of which the Bile cannot be drawn off, or that which is drawn will come near the nature of common Serum or Water; and therefore not being able to perform its office in the Inteſtines, as a warming *Stimulus* or natural Cathartick, an obſtinate Coſtiveneſs and obſtruction of the Bowels will enſue, with a continual Nauſea, loſs of Apetite, and inclination to vomit at every thing.

THIS Error of Digeſtion is often the Conſequence of the former, as the laſt Reſult of it on the contrary Extreme: For the Heat and Efflatus of the Blood having been rais'd too high, and at the ſame time the elaſtick *Fibrillæ* and Springs of Motion overheated and immoderately ſtretch'd, Nature which cannot be always forced, being uncapable of bearing any longer ſuch a continued Tenſion, ſinks at laſt into the oppoſite State, as here deſcrib'd: And thus the hot Intemperance draws on the cold Penance of Nature.

WHERE this ſtate of Digeſtion has been brought on by a long preceding Courſe of Luxury, Drinking and Exceſs, the Caſe is extremely dangerous, and the Patient at beſt has but a lucky Chance for his Life: however, 'tis poſſible that it may not be altogether deſperate; and what help can be obtain'd may be expected from Emeticks frequently repeated, with an obſtinate Courſe of Riding; to which may be join'd the intermediate uſe of the Peruvian Bark, made ſomewhat opening with Rhubarb, and warming with Winter's Bark, wild Valerian, Cinnamon, *Serpentaria*, &c. to which muſt be added the moſt reſolute Temperance, or Moderation, in feeding lightly upon things of an eaſy Digeſtion, and abſtaining from all hot, ſpirituous, and inflammable Liquors, how much ſoever a deprav'd Appetite under theſe Circumſtances may ſeem to call for their former Exceſſes.

A QUESTION may be ſtarted here about things eaſy of Digeſtion, and what Food is moſt proper for Valetudinarians: as to which, if People would only follow the Dictates of Nature, and feed moderately upon that which they find they can digeſt with the leaſt Trouble or Inconvenience, they would need no other Rule; ſo far as this amounts to, a Man of competent Age and Experience muſt certainly be either a Fool or Phyſician; and if he cannot direct himſelf in this, he is not fit to be truſted in any thing.

But not to leave this Matter without ſome account of its Theory, it may be obſerved here, that things made uſe of for Food digeſt very differently, according to the different ſtate and degree of the natural digeſtive Heat; for where this digeſtive heat in the Stomach is too high and intenſe, things of the lighteſt and looſeſt Coheſion and Texture digeſt with the greateſt difficulty: for becauſe of their eaſy and too quick Solution, where the digeſtive Heat is greater than it ought to be, they are apt to run all into a hot, frothy, vapid *Flatus*; which by occaſioning a great Inflation and Tenſion of the Stomach and Bowels, hinders and interrupts the work of Digeſtion: on the other hand, where the natural digeſtive Heat is too remiſs and low, things of the ſlighteſt Coheſion, and ſuch as are ſooneſt diſſolved, digeſt beſt, and paſs off with the leaſt Trouble and Inconveniency; whereas things of a cloſe, hard, and compact Conſiſtence, will not digeſt with ſuch, but with great difficulty, and in the mean while lie like Stones or Lead in the Stomach.

For this Reaſon, a Glaſs or two of Wine, good ſmooth Stale Beer, or any ſuch warming Liquor, is very good in what I here call a cold and hard Digeſtion, to promote and help forward the Decoction, where the natural Digeſtive neceſſarily requires ſuch help: but in the contrary hot and flatulent Digeſtion, any ſuch Liquors at or ſoon after Meals

Meals are always hurtful, and ought not to be admitted at all till the Concoction is finish'd, and the digested Matter pretty well pass'd off; and even then, all that can be said for them, is, that they will be less prejudicial. But People in Health, and whose Digestion is sound and good, need not be scrupulous about any of these Matters; 'tis enough for such to take care only that they eat and drink with Moderation and Temperance, to consult Experience, and to follow the Dictates of sober Nature: But they who from a set of false Reasonings are once persuaded to eat and drink exactly by Weight and Measure, as if they could supply the various and mutable Exigencys of Nature just as they fill a Vessel, the Capacity and Discharges of which are always the same, are in great danger of falling into the Physician's Hands: and this, I hope, may be a sufficient Caution against any such Cook Pedantry, and most ridiculous as well as pernicious Regularity. Such an Oeconomist might as well impose upon himself to stand or sit always in the same Place, to lie in the same Bed, to wear exactly the same weight of Clothes, and to ride or walk every Day precisely the same number of Feet and Inches; nay, he must compound with Providence for continual wet Weather or continual dry, for the same immutable degree of Heat and Cold, and the same invariable constitution of the Air in which he breathes: for 'tis certain that all

these

these may some way or other affect the Constitution, Appetite, and Digestion, so as to require sometimes larger, and sometimes more sparing Meals, and the occasional use of stronger or weaker Liquors. In short, the best Rule that I know for Health, is to observe strictly no particular Rule at all; but upon the general Principle of Moderation and Temperance, to follow the Dictates of sober Nature: And he who in this respect should resolve to govern himself otherwise, as he ought to have nothing else to do, so he must doubtless be a Man of great Consequence.

I HAVE mention'd Vomiting in this cold, low, and remiss state of Digestion; and from hence, I think, may be taken the surest Indication of the Issue or Event: for where Emeticks work well, and after a few Repetitions produce some sensibly good Effect, there may be great hope of Recovery; but where they will scarce work at all, and the muscular Coats of the Stomach and Intestines have so far lost their elastick Tone, or restitutive Force, that the Emeticks lodge upon the first Passages, and cannot be thrown off, but serve only to sink the natural Heat and animal Vigour still lower, it may be taken as a mortal Symptom, and discourage all farther Attempts.

THERE is one Symptom, which I have frequently observ'd in those who have brought themselves into this morbifick state of Digestion,

ſtion, by a previous Courſe of hard Drinking; and that is, an obſtinate, continued, or fix'd Pain in the Stomach; which is moſt ſenſible while the Breaſt is raiſed for Inſpiration, and attended with great difficulty of Breathing. Emeticks have little or no operation after this Symptom has fix'd it ſelf for any conſiderable time; nor have I then known any Inſtance of a Perſon's recovering, whatever other Method might be taken with him.

But this Error of Concoction often comes on without any ſuch Cauſe as a foregoing Courſe of Intemperance and exceſſive Drinking; and may be the Conſequence of immoderate Grief, unwholeſom Diet, or bad Air; as it is the common Caſe of Girls under a *Chloroſis*. But where the Diſeaſe is the ſame, the Method of Cure will be much the ſame, whatever the Cauſe be; only with this Difference, that when ſuch a morbid Conſtitution is the Effect of a long Courſe of Intemperance and Exceſs, it is harder to be remov'd than when it proceeds from almoſt any other Cauſe.

3. It ſometimes happens, that where the firſt Concoction in the Stomach ſucceeds right enough, with reſpect to the meaſure and degree of the natural digeſtive Heat, yet by reaſon of an urinous ſcorbutick Salt ſecreted in the Glands, and thrown upon the firſt Paſſages, the conſequent Precipitation is too ſtrong: from whence it comes about, that not only the groſſer Feculencys, but the

richer Oils and volatile Salts of the Concoction are precipitated and thrown off with the Excrements; and this from the too great *Stimulus* occasion'd by these scorbutick Salts and Sabula, mix'd with a sharp acrimonious Serum.

People of this Constitution eat plentifully, and with a keen Appetite, and yet are not nourish'd or strengthen'd by it; but continue thin, lean, and meagre, and with pale Complexions and hollow Eyes, look as if they were half starv'd. They have an almost continual grating or gnawing at the Stomach, and seem always empty but when they are eating; their Blood is generally low and poor, that is, serous and watry; they make but little Urine, and are for the most part costive; they are apt to sweat, and much reliev'd by it, because this carrys off part of the Salts and Serositys of the Blood, which cannot pass by Urine, and diverts their Course from the Stomach; they are impatient of Abstinence or Fasting, and tempted to eat more than they can digest or carry off; to which a great part of the Disease is doubtless owing, for light Meals, tho the oftner repeated, best agrees with them: they cannot bear strong Liquors, even in an ordinary Quantity; for tho they often do want such Recruits, yet a little will overheat and dry them up: And finally, when this morbid State is left only to Nature, unless good brisk Exercise and great Temperance

rance prevent it, it terminates at laſt in a Dropſy.

THIS Conſtitution is evidently a Scurvy, fixing it ſelf upon the Stomach: from which primary Diſeaſe thus ſeated, all the Symptoms will naturally and neceſſarily flow. The moſt certain and ſpecifick Remedys are the Mercurial and Antimonial Preparations; eſpecially the Æthiops, Cinnabar of Antimony, Diaphoretick Antimony, Bezoar Mineral, and the Antihectick of *Poterius*; any of theſe given either with Winter's Bark and wild Valerian, or with Rhubarb and black Hellebore, as the Conſtitution is either hot or cold, will eradicate the Diſeaſe: and theſe may be variouſly mix'd and compounded, with regard to the Intentions of heating or cooling, as the different turn of the Diſeaſe, or Conſtitution require.

4. WHERE the firſt Concoction in the Stomach is not afterward ſufficiently depurated by the Bile, the Digeſtion will be groſs and feculent: but this is properly a Conſequence of the firſt Error in Concoction, that is, an hot and flatulent Digeſtion; for where the digeſtive heat in the Stomach is too ſtrong, the over-heated rarefy'd Matter will not be capable of a ſufficient Depuration and Precipitation afterward, by the Bile and pancreatick Juice: in conſequence of which, a hot and flatulent will always be a groſs and feculent Digeſtion. And therefore what has been ſaid under that Conſtitution, will be equally

equally applicable to this, which may ſave me the trouble of any farther Remarks or Obſervations here.

PROPOSITION XVII.

TO explain the natural Phænomenon of Sleep, with the Effects of Opium, and ſuch-like ſoporiferous Drugs.

SLEEP is an interruption or ſuſpenſion of Senſation for the time being; which is either total, as in ſound and deep Sleep, or partial only, when the Sleep is diſturb'd, and fill'd up with Dreams: and, in conſequence of the Union of Soul and Body, the Author of Nature has eſtabliſh'd an inſeparable Connexion between certain determinate Impreſſions of outward Objects upon the Organs of Senſation, and thoſe particular Senſations themſelves which are reſpectively excited by them: Inſomuch that the Organ being duly ſtruck and impreſs'd by the Object, and put into a certain vibrating or undulating Motion, the reſpective Senſation neceſſarily follows, and is inſeparably connected with it. From whence 'tis plain, that the Senſation it ſelf muſt be intended, remitted, or ſuſpended, in conſequence of the Intention, Remiſſion, or Suſpenſion of Action in the Organ, or motive elaſtick Nerve by which it is excited. How, or after what manner this is done, is altogether incomprehenſible; but the thing it ſelf being evidently ſo in Fact, it muſt be admitted

mitted as a Law of Nature, as much as the Communication of Motion from one Body to another by Impulſe, or the univerſal Attraction or Gravitation of Matter.

THE proper Action of the Senſorys therefore, or that vibrating undulating Motion into which they are excited by the Impreſſions of Objects, is the proper ſtate of Waking and Exerciſe; as on the other hand, the Reſt or Quietude and Fixation of thoſe Organs is the ſtate of Sleep.

THIS being premis'd, it may be obſerv'd farther, that any change of State, whether from Motion to Reſt, or the contrary, is occaſion'd by a certain painful *Stimulus*, or uneaſy Impreſſion upon the Organs of Senſation and voluntary Motion: for any ſuch Action being either too intenſe, or too long continued, will become painful, from the over-ſtretch and tenſity of the motive elaſtick *Fibrillæ*, by which the Action is exerted and maintain'd. In like manner, Reſt, or the Suſpenſion of Action too long continued, becomes painful; becauſe the Body cannot be long retain'd at reſt in any Poſition, without too ſtrongly compreſſing thoſe nervous ſenſible *Fibrillæ*, upon which the principal Weight is ſuſpended, and which being thus preſs'd and ſtimulated, excites the Senſation of Pain.

NOW where either Reſt or Motion come to be thus painful, the Mind, by a Law of Nature, changes the ſtate of Motion or Reſt from

from one to the other; and this in order to throw off the Pain, and get rid of the present Uneasiness, by relieving the Organs which undergo any such painful Stretch, Tensity or *Stimulus*.

WHILE we thus by any change of State free our selves from any present Pain or Uneasiness, we are affected with a sensible Pleasure; and this is perhaps the only thing in which the Pleasure of Sensation consists: for instance, heating or warming gives us Pleasure, while it serves to throw off any present pain or uneasiness of Cold; but the Heat being carried farther becomes it self painful, and then cooling and refrigeration gives us the same sensible Pleasure by throwing off the Pain, and freeing us from the *Stimulus* of Heat. Thus also when any Sensation or voluntary Motion, being too intense or too long continued, becomes painful, Rest, or a Suspension of any such Action gives us Pleasure, in proportion to the strength of the *Stimulus* and Pain we are freed from: but when such Rest or Suspension of Action comes to be painful, the exchanging it for Motion, and thereby getting rid of the painful Rest, affects us with the same sensible Pleasure: And indeed, we may always observe, that the Suspension of any Action can give us no Pleasure, unless the Action it self becomes antecedently painful; and no Action can affect us with Pleasure, but as the contrary Rest is some way or other painful,

and then the Action becomes a Pleasure, by freeing us from the uneasiness of the contrary state of Rest.

I would not be thought to assert here, that Pleasure is nothing else but the mere Privation of Pain, as if Pleasure was not as real and positive an Idea or Sensation in the Mind as Pain, for that undoubtedly it is: but I am here only considering the Occasion and Origin of those different Sensations; how they are related to each other, and by what Law of Nature they are excited in, and impress'd upon the Mind: and therefore, I say, that as Pain is the Consequence of some over-stretch, tensity, or injurious violence upon the Organs, so Pleasure is excited only by the removal of any such violence, and when that is done the Pleasure ceases: thus he who eats to satisfy or appease his Hunger, finds a Pleasure in eating, only till the foregoing painful *Stimulus* is thrown off; and after this, if he continues to eat on, it will be with Indifferency at least, if not with Pain and Loathing: and he who under the sense of Cold warms himself, feels the Pleasure of warming no longer than till he has thrown off the Pain and Uneasiness of the Cold, and then the Action of warming becomes indifferent, or painful, as it either does not affect the good of the Machine at all, or becomes injurious and hurtful to it.

THAT this is so in Fact cannot be deny'd, and therefore it must be admitted as a Law of Nature: and tho the manner of it, as well as of every thing else, is incomprehensible; yet the Reason and Necessity of it, upon the Principles of rational Forecast, Contrivance and intelligent Mechanism, are very evident. I have observ'd before, that the animal Machine is constructed and form'd upon the Principles of Self-preservation; of which we cannot perhaps have a more convincing Proof than that which we are now considering: for nothing can be imagin'd more conducive or effectual to the Preservation of the animal Machine, than these strong prevailing Impressions of Pleasure and Pain, so rais'd and impress'd by a fix'd and standing Law, as to excite and determine us by a sort of necessity to choose what is good and beneficial, and to avoid whatever is hurtful and destructive to the animal Nature. Upon this Principle of Wisdom, Contrivance, and Self-preservation, when the Pain, and consequently the Violence upon the Organs which occasion'd it, are taken off, the Pleasure of the means which procured any such Relief ought to cease, to let us know, that being now in a state of mere Indolence or Indifferency, with respect to Pleasure and Pain, we are at perfect liberty whether we will continue the present State, or exchange it for another: on the other hand, when any present State, whether of Motion or Rest, becomes hurtful

and injurious to the animal Conſtitution, 'tis neceſſary that that which before was attended with Pleaſure ſhould now give us Pain, to make us ſenſible that we are in danger; and that the hurtful Violence upon the Organs which occaſions the Pain, ought to be remov'd by a change of State, whether from Motion to Reſt, or the contrary.

But againſt what I have advanc'd in general, that the Pleaſure of Senſe is only the Conſequence of a Relief from Pain, and that the Pleaſure ceaſes when the Pain or the occaſion of it is remov'd; it will perhaps be objected, that there are ſome things which affect the Organs with a very ſenſible Pleaſure, where there was no antecedent Pain to be remov'd; and that conſequently the Principle does not ſeem univerſal, or unexceptionable enough to be made a ſtanding Law of Nature: thus, for inſtance, any delicious Food or Fruit will have its Effects upon the guſtatory Nerves, by exciting Pleaſure, tho there was antecedently no Hunger, Thirſt, or any other Pain of that ſort to be removed. And after the ſame manner, Muſick or Harmony will affect the auditory Nerves with an agreeable Emotion, ſo as to excite the Pleaſures of Sound, tho the Senſe of Hearing was not any ways painfully affected before; and conſequently it ſhould ſeem from theſe and ſuch-like Inſtances, that the Pain or Uneaſineſs is not neceſſary to the Pleaſure of Senſation.

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But in anſwer to this, it muſt be obſerv'd, that the Action of ſuch Objects upon the Organs is of a mix'd or complicated Nature, and that the Senſations and Denominations of Pleaſure or Pain are taken from that which is moſt prevailing: Such delicious Foods therefore, Fruits or Liquors, which independently of any foregoing Pain of Hunger or Thirſt, affect the Senſe of Taſt with Pleaſure, are of a mix'd Compoſition, and contain in them an acid, or ſharp pungent Salt, join'd with a volatile inflammable Oil, duly united and blended together: now either of theſe alone, by a too forcible *Stimulus* upon the Organs, would occaſion Pain; the one by its over-cooling, condenſing, and fixing Quality, and the other by its immoderate heating, attenuating, and rarefying Propertys: but while the oppoſite Principles are mix'd in due proportion, the *Stimulus* impreſs'd by the one is immediately taken off, or qualify'd and reſtrain'd by the other; from which conjunct Action of the contrary Principles, the guſtatory Nerves are kept in a quick, but ſoft eaſy Undulation, in which conſiſts the Pleaſure of the Taſt: but where either of the foregoing Principles are too predominant, or not ſufficiently qualify'd and reſtrain'd by the other, the delicacy of the Guſt or Flavour will be loſt, and the Taſt will become ungrateful or painful.

THE like may be underſtood with reſpect to Muſick or Harmony, which conſiſts in an artful mixing and compounding of Concords with Diſcords; or in a quick and ſudden covering and reſtraining ſuch Slurs and Jars which otherwiſe would ſtrike the Ear too forcibly and occaſion Pain, and yet without which the Pleaſure from the Muſick could not be excited.

HAVING premiſed thus much concerning Pleaſure and Pain, ſo far as they ariſe from the alternate Motion and Reſt of the Organs of Senſation and voluntary Motion, it may now be obſerv'd farther, that theſe Organs reſpectively are the only ones in the whole Body that are capable of a perfect Reſt, Fixation, or ſuſpenſion of Action: for voluntary Motion being under the Command and Direction of the Will, muſt ceaſe when the Will ceaſes to act; and conſequently the Organs by which ſuch Motion is perform'd, muſt remain in a ſtate of Reſt: and the Organs of Senſation being mov'd and excited to their proper Action by the Impreſſions of Objects, when theſe Organs are withdrawn from their Objects, or by any means compreſs'd and fix'd beyond the moving Force of ſuch Impreſſions, theſe Organs muſt in conſequence be neceſſarily fix'd, and remain likewiſe in a ſtate of Reſt: But the Muſcles of involuntary, or mere natural neceſſary Motion, and the Glands by which the neceſſary Secretions are made, continue their Action

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inceſſantly in a natural and regular State, whether we are ſleeping or waking: for the Action of theſe being natural and neceſſary, and not depending on any Act of the Will or Impreſſion of Objects, they muſt conſequently continue to act and perform their ſeveral and reſpective Offices, whether we think and exert any voluntary Motion or not.

But tho the Action of the ſecretory Organs, and of the Muſcles of mere natural neceſſary Motion be continual, yet it is liable to various Intenſions and Remiſſions, the Conſequences of which being very conſiderable, muſt be firſt explain'd before we proceed farther.

The muſcular Action of the Heart, the Lungs, the Diaphragm, the intercoſtal Muſcles, and the muſcular Coats of the Arterys in general, is very much ſtrengthen'd and invigorated by any briſk voluntary Motion or Exerciſe, as is commonly known; and the Reaſon of it is ſo evident, from what has been obſerv'd and conſider'd under the Theory of muſcular Motion, that it need not be farther inſiſted on here: but that which I am here moſt of all concern'd to take a particular Notice of, is, the vermicular or periſtaltick Motion of the Bowels, which is propagated from the *Oeſophagus* (where it begins) thorow the whole Length of the Stomach and Inteſtines to the *Anus*: For almoſt all voluntary Motion or Exerciſe, eſpecially if it be ſtrong and vigorous, muſt neceſſarily

ſhake and ſtimulate the Stomach and Inteſtines, and thereby raiſe and ſtrengthen their muſcular Force and Action. But when this Action, being too intenſe or too long continued, becomes painful, Reſt or Sleep, by taking off the foregoing *Stimulus*, muſt remit, weaken, and depreſs the ſame muſcular Force and Action, in the ſame proportion that it had been raiſed and ſtrengthened by the foregoing voluntary Motion and Exerciſe: and the ſame is farther evident from the Secretions or Evacuations of the Stomach and Inteſtines, which are always conſiderably leſſen'd and abated by Reſt and Sleep; inſomuch that a Vomiting or Diarrhæa ſtops during that Interval: the Reaſon of which is plainly this, that the *Stimulus* upon thoſe Organs, occaſion'd by Senſation and voluntary Motion, being taken off and ſuſpended by Sleep, the periſtaltick Motion which was before too intenſe, is now remitted or leſſen'd; and conſequently the Contents of the Stomach and Inteſtines, before in a violent Motion from the too great Efforts of the elaſtick Fibres, are now ſuffer'd to reſt quiet and undiſturb'd.

THESE things preſuppos'd, we may now give a ſhort and eaſy Solution of the natural State or Phænomenon of Sleep; to which purpoſe it may be obſerv'd, that the Organs of Senſation and voluntary Motion, having been continually employ'd for about ſixteen Hours, more or leſs, their Action from ſuch con-

continued ſtretch and tenſity, becomes painful; which determines the Mind to change this ſtate of Action for a ſtate of Reſt, in order to get rid of the preſent Uneaſineſs: to which End the Perſon having freed himſelf from the Pain of Hunger and Thirſt, places himſelf in a ſoft and eaſy poſition, and under a temperature of Heat and Cold, retir'd from the noiſe, buſtle, and impreſſion of Objects, compoſes himſelf to Reſt: this Reſt at firſt raiſes a ſenſible Pleaſure, till the Uneaſineſs of the foregoing ſtate of Action is thrown off, and then the Pleaſure ceaſes, and the Perſon is reduced to a ſtate of mere Indolence or Indifferency, with reſpect to Pleaſure or Pain; in conſequence of this indolent Reſt or Quietude, the Organs of Senſation fix, and their Action is ſuſpended: therefore thoſe Ideas and Senſations which are excited by ſuch organical Action, muſt likewiſe be ſuſpended; that is, the Perſon will be in a ſtate of Sleep, which is nothing elſe but a Suſpenſion of Senſation, as the neceſſary Conſequence of the Reſt or Fixation of the Organs.

I HAVE obſerved before, that upon this Reſt, or ſuſpended Action of the Organs of Senſation and voluntary Motion, a conſiderable *Stimulus* upon the Stomach and Inteſtines being hereby taken off, the muſcular Force and periſtaltick Motion of thoſe Bowels will be very much abated; of which Diminution of the periſtaltick Motion, the Conſe-

Conſequence will be plainly this; That a certain quantity of Blood, which by the Force of the foregoing *Stimulus* had been derived downward, thorow the deſcending Trunk of the *Aorta*, will, now the *Stimulus* is taken off, from the Reſiſtance it meets with in its former Courſe, be oblig'd to paſs upward thorow the aſcending Trunk of the *Aorta*, to the Head and ſuperior Parts: from this greater and more plentiful Afflux of the Blood, and riſing of the vital Tide, the cervical and carotid Arterys in the Brain will be moderately fill'd, ſtretch'd, inflated and diſtended; and theſe Arterys thus fill'd, and diſtended with a greater Quantity of Blood, muſt preſs upon the Senſorys, or thoſe Nerves which are the Organs of Senſation in the Brain, and thereby farther contribute to ſtop and ſuſpend their Action, and continue the Animal in the ſtate of Sleep.

From the ſame Compreſſure and Conſtipation of the Nerves of the eighth Pair, or the *Parvagum* at their original in the Brain, the ſeveral Branches of this pair which are diſtributed to the *Oeſophagus*, Stomach, Meſentery, Liver, Spleen and Kidneys, will have their muſcular Force moderated and reſtrain'd, after they had been brought into a too ſtrong and forcible Action, by the *Stimulus* impreſs'd upon them in a ſtate of Watching and Exerciſe.

Now from all this it appears, that as by Senſation, Watching, and Labour or Exerciſe, when too intenſe or too long continued, the

the vital Tide is ſunk and depreſs'd, the natural Heat recall'd and concentred, the Blood thrown in too great Quantitys downward, eſpecially upon the Organs contain'd in the Abdomen; by which their Action becomes too intenſe, their Nerves over-ſtretch'd, and their Offices interrupted: ſo on the other hand, by Sleep the vital Tide together with the natural Heat, are raiſed and diffuſed, the Pulſe ſtrengthen'd and quicken'd, the oppreſs'd Bowels and overſtrain'd Nerves reliev'd, and the *Æquilibrium* of the circulating Blood, which had been loſt by too violent or long continued Motion, is again reduc'd to its natural balance and regular ſtate: from which 'tis evident of how great neceſſity and importance Sleep is, in its natural periodical Returns, to raiſe the ſinking Tide of the Blood; to keep up and diffuſe the natural Heat; to relieve the over-loaded inferior Organs, and give Nature a ſort of breathing-time, to unbend and recover the over-ſtrain'd Springs of Motion: and therefore it muſt be allow'd as one of the greateſt Bleſſings with which Providence has befriended our weak, languiſhing, and continually decaying Conſtitutions, that when Sleep cannot be obtain'd in a natural way, and in the manner already explain'd, we are furniſh'd with an almoſt certain and infallible Remedy to procure it, and to eaſe and mitigate thoſe ſharper and more intenſe Pains, which would otherwiſe effectually prevent it.

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EVERY one will ſee, that what I here mean is Opium, or the concreted inſpiſſated Juice of Poppys; by which wonderful Drug, rightly manag'd, Eaſe, Reſt, and Sleep may be procur'd in the greateſt Exigencys, and under the acuteſt Pains; and thereby a Truce obtain'd with many Diſeaſes, which muſt otherwiſe, very often without Help or Remedy, ſoon diſſolve and ſhatter in Pieces the animal Machine.

OPIUM abounds exceedingly with a moſt rich and generous volatile Oil and Salt, mix'd with a certain proportion of Reſin, or a more fix'd, ponderous, and ſtimulating Oil and Salt: but its prevailing Principle, and that upon which its moſt wonderful Effects depend, is undoubtedly that natural and extremely benign *Sal volatile oleoſum*, with which it ſo plentifully abounds.

THE firſt and moſt ſenſible Effect of Opium, when taken into the Stomach, is a certain agreeable Senſation, or entertaining amuſing Pleaſure which it excites, and which ſeems to diffuſe it ſelf throout the whole animal Frame; of which Pleaſure, the firſt and moſt ſenſible Impreſſions are made upon the Stomach, *Oeſophagus*, and Bowels, from whence it ſoon aſcends, and affects the Brain. During this effect of Opium, the Thoughts are thrown into an agreeable Confuſion, and the Mind is taken off from all other Objects and Concerns, to attend the preſent pleaſurable Impreſſions upon the Nerves: In this

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ſtate of ecſtatick Quietude, the Pulſe riſes and beats quicker and ſtronger, the natural Heat is diffuſed, and the vital Tide viſibly riſes and ſtrengthens, with a natural eaſy Afflux to the Head: in conſequence of which, the cervical and carotid Arterys being fill'd, and moderately diſtended with Blood, and preſſing upon the Senſorys and Springs of Motion in the Brain, their Action is hereby ſuſpended, that is, the Perſon is reduced to a ſtate of Sleep.

If the Quantity of Opium given, be ſomewhat leſs than what is neceſſary to induce a ſound Sleep, it affects the Perſon only with the foregoing pleaſant confuſion of Ideas, and entertains him with a thouſand pretty vagrant Phantoms and agreeable Images, as in a Dream, or betwixt ſleeping and waking. But if Opium be given in a ſtill lower Doſe, it ſerves only to ſtrengthen, animate, and invigorate, and to fit a Man for the neceſſary Offices and Requirements of a ſtate of Waking and Exerciſe; like a moderate Quantity of Wine, an enlivening Dram, or any ſuch ſort of agreeably warming Liquor. And thus its Effects gradually riſe, from a pleaſing, ſtrengthning Invigoration, to a deep and ſound Sleep; which Sleep, if the Doſe be too ſtrong, may happen to be lethargick, apoplectick, and incurable.

These are the moſt general, conſtant, and peculiar Phænomena attending the uſe of Opium, in all Perſons, and at all Times:

according to the Quantity in which it is given: it ſtrengthens and invigorates, eaſes Pain, raiſes Pleaſure, and at laſt terminates in Indolence, Inſenſibility and Sleep.

But before I proceed farther, it will be proper to obſerve here, as a thing of great Conſequence, that theſe peculiar Effects of Opium, *i.e.* the animating Invigoration, ecſtatick pleaſurable Confuſion, and gradual Sleep which it brings on, are confin'd for the moſt part, if not wholly, to the inward uſe of it, or where it is receiv'd into the great depuratory and expurgatory Organ of the concoctive Gland, that is, into the Stomach and Inteſtines: but from the outward Applications of it, in Plaiſters, Lotions, Unctions, *&c.* no ſuch Effects will follow, at leaſt not in any conſiderable or remarkable degree.

'Tis true, indeed, that Opium when outwardly apply'd, as aforeſaid, has a mighty Efficacy in taking off an Inflammation, eaſing the Pain of a ſuppurating Abſceſs, and diſcuſſing of windy and flatulent Tumors; and to theſe Purpoſes I have ever uſed it with great Freedom, and with equal Succeſs: and tho it cannot be doubted, but that in ſuch an Application and Uſe of it, very conſiderable Quantitys of the more ſubtile, volatile, and active Parts of the Opium, muſt paſs into the Blood, and circulate together with it; yet I have never obſerv'd any direct ſoporiferous Effects from it when thus apply'd,

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but the Sleep which ſometimes follows ſeems to be purely natural, and ſuch as muſt have been the Conſequence of a Relief from Pain, tho it had been procur'd by ſome other means, and without the uſe of any Opiate at all.

THUS far is matter of Fact and Experience, and the accounting for theſe Phænomena will let us into the whole Myſtery of Opium, and ſerve to explain all its Operations, and different Effects and Conſequences of it, whether good or bad, under the ſeveral particular Circumſtances and Conditions of Action. But the better to clear the way to this, it will be neceſſary in the firſt place to conſider a little farther the nature of Pleaſure and Pain, by what Mechaniſm they are produc'd, and after what manner they differently affect the nervous elaſtick Organs. I ſay therefore, that Pleaſure and Pain, in their Origination and mechanical Production, depend on the different nature of the *Stimulus*, or Modification of Motion impreſs'd upon the motive *Fibrillæ*, or nervous elaſtick Organs.

'TIS well known, that any violent *Stimulus*, or too ſtrong Impreſſion of Motion upon a particular Organ, by deriving a more than ordinary quantity of Blood to the ſtimulated Part, and thereby overſtretching and wounding, or breaking the motive, elaſtick, and ſenſible *Fibrillæ*, will occaſion Pain; which Pain is the Notification given us by a Law of Nature, of any ſuch hurtful injurious

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Stimulus, that we might from hence be excited, and in a manner neceſſitated to take the proper Meaſures and Precautions for Self-preſervation. On the other hand, Pleaſure is excited by a quick, but ſoft, eaſy, and as it were harmonious Tremulation, or placid undulatory Motion impreſs'd upon the Organs. Under this Circumſtance or Modification of Motion, the Blood and circulating Fluids will recede from, or rather flow in a leſs quantity to the Parts thus gratefully and agreeably impreſs'd, and be deriv'd in a greater proportion to other Parts, where the *Stimulus* is ſtronger; and in conſequence of this, the nervous elaſtick *Fibrillæ* will contract, and recover themſelves more and more at every returning placid Undulation: when by this means the Over-ſtretch or painful Tenſity of the Fibres is taken off, and they have obtain'd their utmoſt Reſtitution and proper Reſt, the Pleaſure will ceaſe, and terminate in mere Indolence, in which the motive *Fibrillæ* will remain indifferent, with reſpect to Pleaſure and Pain.

THESE things premiſed, the various Operations of Opium, and the ſeveral Circumſtances under which it may do either good or harm, may be now eaſily explain'd: To which purpoſe it may be obſerved in the firſt place, that the Opium being receiv'd into the Stomach, and there attenuated and diſſolv'd by the natural digeſtive Heat; the volatile oily Salts with which the Opium moſt plentifully abounds,

abounds, will be raiſed into a warm invigorating placid Steam, or grateful and eaſy Efflatus; from which moſt agreeable and placid Efflatus, the nervous Coats of the Stomach, *Oeſophagus*, and Inteſtines, will be affected by immediate Contact, with a quick, ſoft, eaſy and undulating Titillation: and upon this account it may be ſaid, that Opium affords the ſame pleaſurable Guſt, or agreeable Senſation to the Stomach, and, as we ſhall ſhew, to the Nerves in general, that a Pine Apple or ſome ſuch delicious Fruit, does to the guſtatory Nerves upon the Tongue and Palate: For indeed, the Pleaſure of Opium is ſo great, ſo extenſive and generally diffuſed, and at the ſame time attended with ſuch variety of pleaſing Images, that it cannot be known or underſtood but by thoſe who have try'd it, under ſome antecedent painful *Stimulus*, or preſſing Uneaſineſs; and thereby acquainted themſelves with the wonderful Relief and ſenſible Pleaſure it gives by Experience.

IT muſt be obſerv'd in the next place, that the *Oeſophagus*, Stomach, Inteſtines, and all the Viſcera contain'd in the Thorax and Abdomen, are ſupply'd with Nerves, not from the ſpinal Marrow, but from the Branches and Ramifications of the Nerves of the eighth Pair, or *Par vagum*, which takes its riſe in the Brain it ſelf, by numerous ſmall Filaments ſpringing from the ſides of the *Medulla oblongata*; and from hence it muſt

come about, that when the Branches of the *Par vagum*, which ſupply the *Oeſophagus*, Stomach and Inteſtines, are affected by immediate Contact with the foregoing eaſy placid Motion and Senſation, the other Branches and Diviſions of the ſame Nerves in the Heart, Liver, Spleen, Meſentery, Kidneys, *&c.* muſt be brought into the ſame pleaſurable Motion and Senſation, by Conſent and Communication: and this muſt be continu'd thro all the Branches and Ramifications of the ſame pair of Nerves, up to their original in the Brain. And indeed, all the Nerves, by their natural and neceſſary Communication with each other, will be affected in ſome meaſure after the ſame manner; as the ſeveral concordant Strings of a muſical Inſtrument will receive the ſame Modification of Motion, when one of them is ſtruck, tho the greateſt Emotion and moſt ſenſible Effects will be obſerv'd upon that String which was directly and immediately impreſs'd. And thus any painful *Stimulus*, wherever it happens, may be taken off by the uſe of Opium, in conſequence of this ſort of harmonical propagation of Motion from one Nerve to another; tho the Pain does not reſide directly in any of the Branches and Ramifications of the *Par vagum*, which are firſt and moſt immediately affected by the Opium, as above explain'd.

Now this eaſy undulating placid Motion of the Nerves, being continued till all the painful *Stimulus* upon the Parts is taken off, and till the Organs of Senſation have obtain'd their greateſt ſtate of Contraction, Reſtitution, and Reſt; the Pleaſure then ceaſes, and terminates in Indolence: and the Action of the Senſorys being thus ſuſpended, there muſt be conſequently a Suſpenſion of Senſation; that is, the Perſon will be reduc'd to a ſtate of Sleep.

But farther, from the eaſy, agreeable, and moſt placid Efflatus in the Stomach, occaſion'd by the rarefy'd or ſublimated volatile oily Salts of the Opium, the Stomach will be moderately and pleaſurably inflated and diſtended; and by that means bear upon the deſcending Trunk of the *Aorta*: at the ſame time all the painful *Stimulus* or Irritation upon the Organs, which are ſupply'd with Blood from the deſcending *Aorta*, being taken off, the Blood which was before deriv'd in too great Quantitys to thoſe Organs, ſo as to over-ſtretch them, will now from both theſe Cauſes conjunctly, be ſent in a greater quantity and proportion to the Head and ſuperior Parts: and this muſt ſtrengthen and confirm the diſpoſition and ſtate of Sleep, in proportion as the Senſorys in the Brain are compreſs'd and fix'd by the turgid diſtended Blood-Veſſels.

FROM this general account of the nature of Opium, and the manner of its Operation, it will be eaſy to underſtand the true uſe of it, and in what particular Caſes, or under what Circumſtances it may do either good or hurt: for that Man certainly is not fit to give Opium, or any thing elſe of efficacy, who is not duly appriz'd of its ill as well as of its good Conſequences; and there cannot be a ſurer mark of a Quack, or an Ignoramus in his Profeſſion, than to hear a Man cry up any thing as unexceptionably good, or declaim againſt it as univerſally hurtful. I know the common People are exceeding fond of univerſal Remedys, and Catholicons in Phyſick, tho there is nothing in which they are more abuſed and miſled, or from which they ſuffer greater Miſchiefs and Inconveniencys with regard to their Health; ſince this gives Quacks and knaviſh Pretenders an opportunity of picking their Pockets, by impoſing on them things of no value at a great price. But this, however, may be taken as a general Rule in Phyſick, That there is nothing which in ſome Caſes will do a great deal of good, but what will certainly do as much harm in others: and this is eſpecially verify'd in the Caſe of Opium, which is either a great Friend or a great Enemy to Nature, juſt as it is apply'd and made uſe of. For the ſake therefore of young Phyſicians, I ſhall here make ſome practical Obſervations,

by which the foregoing Theory may be the better underſtood and apply'd.

1. 'Tis of great conſequence to obſerve, that Opium, with regard to its proper, direct, and immediate Action, is purely and ſimply a Nervine, and affects the Fluids only ſecondarily and ſymptomatically, by means of the different Determination or Modification of Motion with which it impreſſes the Solids, or the motive, elaſtick, and ſenſible *Fibrillæ:* For ſince it immediately affects the Nerves, or motive elaſtick Fibres, with a ſoft, ſmooth, eaſy, and placid Undulation, 'tis manifeſt that its great and principal Efficacy muſt conſiſt in reſtraining and moderating any violent and preternatural *Stimulus*, or too ſtrong and forcible Impreſſion of Motion upon the Nerves. By this means, any immoderate Afflux of the Blood or Humours to a particular Part, being check'd, ſuſpended, and diverted ſome other way, Nature has time to breathe, and recover the *Æquilibrium* which had been loſt by any ſuch too ſtrong and forcible Irritation and *Stimulus:* And hence it is, that Opium is ſo effectual in ſtopping a Diarrhæa, and in checking and reſtraining any immoderate Flux of the Blood or Humours, which had been occaſion'd by ſome violent *Stimulus* or Irritation upon the muſcular and glandular Organs: for this Irritation and Violence being taken off, by the grateful Impreſſions of the Opium upon the nervous, motive, and ſenſible *Fibrillæ*; 'tis evident

that the immoderate Afflux of the Fluids to the ſtimulated Parts, muſt hereby be reſtrain'd, moderated, and diverted another way.

Now this being the peculiar and moſt direct effect of Opium, to check and reſtrain any violent *Stimulus*, or too forcible impreſſion of Motion upon the Nerves; 'tis manifeſt that the injudicious unſeaſonable uſe of it muſt do a great deal of miſchief: for by this means it muſt gradually weaken and deſtroy that Elaſticity and motive Force of the *Fibrillæ* which is natural and neceſſary, ſuſpend and lock up the natural Evacuations, diminiſh the Velocity of the Blood, and at laſt induce a general ſtagnation of the animal Fluids, for want of elaſtick Force ſufficient to keep up and carry on their Motion and Circulation.

Where any ſuch injudicious and immoderate uſe of Opium has induc'd a too great Quietude and Fixation of the Nerves, and a conſequent Viſcidity and coheſive Lentor of the Fluids, ſticking upon the Glands and clogging the principal Springs of Motion; the beſt Reſtoratives, and moſt effectual means of recovering ſuch an impair'd Conſtitution, will be a keen, dry, and ſtrongly elaſtick Air, cold bathing, Water-drinking, often riding, and daily Exerciſe; frequently repeated Vomits, fœtid aromatick Bitters, and the milder and ſafer Preparations of Mercury and Antimony, made opening with Rhubarb, and eſpecially join'd with black Hellebore.

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2. As the far greateſt quantity of Blood is ſent downward thorow the deſcending Trunk of the *Aorta*, it comes about from hence, that thoſe Bowels and Organs which are continually ſupply'd with Blood by this way, are moſt liable to be clogg'd, and overloaded with a too great Weight and Impetus of the Blood and Lymph; eſpecially after long Watching, hard Labour, great Cold, immoderate Grief, and ſuch-like Cauſes. To remove and remedy which, while the Injury is recent, and before the Diſorder is too ſtrongly fix'd, Opium has a moſt certain and prodigious Efficacy; and this it does by raiſing the vital Tide, quickning and ſtrengthning the Pulſe, and diffuſing the natural Heat, after the manner already explain'd.

But then if too much indulg'd, or continu'd beyond the reaſon and neceſſity of the Caſe, it muſt needs be follow'd with Evils on the contrary extreme, equally miſchievous and deſtructive with thoſe which it was intended to remove: for beſides the general ill Conſequences already mention'd, the immoderate or unſeaſonable uſe of it for the reaſon now aſſign'd, diſpoſes to Lethargys, Apoplexys, Vertigoes, Blindneſs, and the moſt dangerous Spaſms or Convulſions, eſpecially of the Head and Stomach. In ſhort, there are no Diſeaſes which are commonly brought on by the too large and liberal drinking of hot fermented Liquors, and inflammable Spirits, but what may be induc'd by the immo-

derate uſe of Opium: And indeed the Danger is the greater to thoſe who have taken to it, from the innocent Pleaſure it ſeems to give, and the ſilent inſenſible manner in which it draws on the long train of unſuſpected Evils.

3. In all condenſing Colds, which throw the Lymph and Serum immoderately upon the Glands; in violent Coughs, beginning Conſumptions, and all Injurys of the Bronchia; while they are recent, and before the Glands are too much loaded, and the obſtructing Matter obſtinately fix'd, Opium, under a careful Management, is extremely beneficial: for by reſtraining and reducing the violent Motion of the ſtimulated Nerves, it prevents the farther Derivation of the Blood and Serum to the Parts affected; and by thus giving the over-ſtretch'd *Fibrillæ* liberty to contract and reſtore themſelves, they will be enabled to renew their Action, and to throw off the ſtagnating Matter that is already lodg'd upon the Glands. And this is the firſt and beſt end that can be put to ſuch Evils, becauſe it nips the Diſeaſe in the bud, and cuts off its ſupplys of freſh Nouriſhment, before it is too far grown and advanced.

But I would not have it concluded here, that Opium in this Caſe will effect the Cure without any farther aſſiſtance: for tho it may poſſibly, under a skilful Direction, even of it ſelf cure a beginning or ariſing *Phthiſis*, yet it is hardly ever to be truſted alone; ſince

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in any case which requires much time, after the Opium has taken off the preternatural *Stimulus* upon the nervous motive *Fibrillæ*, it will by its continu'd use, without abundance of Care, destroy their natural Action too, and bring them to such a state of Fixation and Rest, as to render them uncapable of their proper and necessary work.

But before the Matter can come to this pass, the observing Physician will have a plain and natural Indication of what he is to do farther: for when the viscid cohering Serum begins to be thrown off from the tumefy'd obstructed Glands, in the manner and by the means just now mention'd, Nature, for the most part, endeavours presently to discharge the vitiated Lymph into the Stomach, in order to be thrown out of the Body that way; and this soon discovers it self by Nauseas, Loathings, and an inclination to vomiting: Vomits therefore in this case are plainly indicated, and in fact scarce ever fail to answer the Intention. For Emeticks, given under a proper Direction, and repeated as occasion serves, that is, till the Symptoms vanish, soon perfect the Cure: and nothing can be more natural, reasonable, or safe, than this Operation; by which the putrefy'd vitiated Principles of such Diseases are drawn off from the Blood, and cast out of the Body, as fast as they are discharg'd from the tumefy'd obstructed Glands.

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But where any Diſeaſe of this kind is too far advanced, that is, where the affected Glands are ſo far loaded and diſtended, or tumefy'd and inflam'd to ſuch a degree, that the Matter cannot admit of Diſcuſſion, but muſt neceſſarily come to a Suppuration and Abſceſs; Opiates in this caſe can do no good, but muſt certainly do a great deal of hurt, with reſpect, I mean, to the Diſeaſe it ſelf; unleſs it be merely for the ſake of preſent Eaſe, when that is the only thing in the Phyſician's power.

4. There is one particular Caſe in which Opiates are of excellent uſe, and which therefore I here beg leave to mention, for the ſake of young Phyſicians; ſince they who are abler and more experienc'd in their Profeſſion, can have no need of it: what I mean is the Caſe of Childbearing Women, who are often tormented for many Days together, and ſometimes for ſeveral Weeks, by turns, with ſlow, lingring, grinding, but ineffectual Pains; by which Nature is frequently weaken'd, and depreſs'd to ſuch a degree, before the great Exigence, that ſhe ſinks at laſt under the weight and burden of the Work: beſides, the Child having been long ſtimulated and pain'd, grows ſtill weaker, and is many times by its Efforts under the *Stimulus* and Pain, entangled and thrown into a wrong Poſition, ſo as to render the future Birth impracticable without great violence. In this caſe Opium is the only ſafe effectual Remedy; and a noble

noble Pacifier both of the Mother and Infant: nor need any one fear leſt by this means the natural time of the Birth ſhould be protracted, and injury done that way; for when the Pains come in earneſt, and to good purpoſe, they will eaſily explain their Nature and Deſign, and the ſpeedy Event will put the whole matter out of doubt.

But moſt pernicious is the Practice of thoſe, who at the ſuppoſed time of Delivery, give what they call *Forcers* to haſten on the work; by which Nature being forc'd upon an unreaſonable ſtretch, the Birth precipitated, and the Ligaments violently torn off; an Hemorrhage often enſues, with a fatal Criſis, which leaves no farther work either for Phyſician or Midwife: but even at this Seaſon, if neceſſity requires, a moderate Doſe of an Opiate given, that Nature may have a little time to breath, and to wind up the Springs of Motion, in order to renew the work with freſh Efforts, is certainly the ſafeſt and moſt rational way.

What has been ſaid of the lingring ineffectual Pains afore the Birth, may be equally underſtood of the after-Pains, which when ſharp, intenſe and violent, muſt be effectually reliev'd by Opiates in ſufficient Doſes: this not being done, a Fever often enſues, more perilous than the Labour, and in which the greateſt danger is yet to come. And indeed, when Opiates are given ſo far only as to take off the Pain, and recover the elaſtick

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Tone of the over-ſtrain'd Veſſels, nothing can be more effectual to bring off the after-Birth, and promote the neceſſary Cleanſings, whatever ſome may imagine to the contrary: but when the Pain is remov'd, and the Strength a little recover'd, the Opium has done its work by anſwering its proper end; and then any Man's Reaſon will tell him that it ought to be laid aſide.

5. NOTHING is more expected or deſir'd by young Phyſicians, than to be rightly inform'd of the juſt and certain Doſes of Medicines; and yet there is perhaps no particular, in which the moſt able and experienc'd are leſs capable of giving them Satisfaction: for my own part, I have always thought the pains of thoſe Gentlemen to be very much loſt, who have gone about to adjuſt nicely the Doſes of Medicines, which is a work, I muſt acknowledge, that my Philoſophy is not at all equal to, and in which, I think, a Phyſician can have no ſure Guide but Experience. They who have writ of Opium, have been eſpecially careful to limit the Doſe of it; which, in general, they will not allow to exceed three or four Grains at moſt: but from this Limitation, if taken as a general Rule, a young Practitioner will ſcarce be ever the wiſer; for as ſuch a Doſe in ſome Caſes may be enough to kill, ſo in others it will be of little or no conſequence. In general, it may be obſerv'd, that in all Diſeaſes where there is any great Afflux and Determination of

Blood

Blood to the Head, the uſe of Opiates ought to be reſolv'd upon with great Caution, ſince in ſuch Caſes ſmall Doſes are ſometimes attended with very bad Effects; but where there is any ſtrong and violent *Stimulus* and Pain in the inferior Parts, as the Stomach, Inteſtines, or Abdomen, deriving the Blood very powerfully downwards, and which threaten a Gangreen or Mortification of the Bowels, Opiates muſt be given freely and in large quantitys, till they have anſwer'd their end: for in ſuch Exigencys, a Phyſician muſt not ſtand by and loſe his Patient in point of Ceremony, or from any trifling regard to canonical ſtated Doſes; and if three or four Grains will take no effect, the ſame Doſe muſt ſometimes be repeated once more, or perhaps twice in the ſpace of ſix or eight Hours; which I have ſometimes found to be no more than neceſſary. I ſpeak not this, however, to encourage young Phyſicians to venture on any ſuch high Doſes ſlightly, but only to ſhew the Neceſſity of diligent Obſervation and Experience, and the Inſignificancy of any general Rules and Precepts in Phyſick without it.

PROPOSITION XVIII.

TO explain the Origination and Mechaniſm of the PASSIONS, *with regard to their different Modifications, and Impreſſions of Pleaſure and Pain.*

WE

We find, by reflecting inwardly upon our ſelves, that there are various Modifications and Impreſſions of Pleaſure and Pain, inſeparably annex'd by a certain eſtabliſh'd Law of Nature, to the ſeveral Judgments we form concerning Good and Evil: theſe Judgments, with their peculiar Modification of Pleaſure or Pain annex'd, according to the various Appearances and Relations of the Object conſider'd either as Good or Evil, preſent or abſent, certain or uncertain, probable or improbable, poſſible or impoſſible; and affecting the Machine after a certain particular manner, peculiar to the diſtinct Modification, are what we call *the Paſſions*.

In every Paſſion therefore, there are three things to be conſider'd, as neceſſary and eſſential to it:

I. The bare intellectual Judgment concerning the Object, under its peculiar and reſpective Qualifications and Appearances, as aforeſaid.

II. The particular and determinate Modification of Motion, hereby impreſs'd upon the Organs, or elaſtick motive *Fibrillæ*, in conſequence of ſuch a Conſideration and Appearance of the Object. And,

III. The peculiar Modification of Pleaſure or Pain, which is at the ſame time excited in and impreſs'd upon the Mind.

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I DESIGN not here an exact, methodical, or ſyſtematical Diſcourſe of the Paſſions; but to conſider them only ſo far as they come within the Province of a Phyſician, or with reſpect to the different Effects and Conſequences of their various and different Modifications and Impreſſions of Pleaſure and Pain: and therefore it may be obſerv'd, that all the Paſſions ariſe, and are generated and form'd, from that natural Principle of Self-preſervation, or neceſſary invincible Deſire of Pleaſure or Happineſs, which is eſſential to every intelligent Being, and which is the great and only Spring of intelligent Action. I do not ſay that the Pleaſures and Pains attending the Paſſions are the only Cauſes, or properly ſpeaking any Cauſes at all of Action; for in ſtrict ſpeaking, the Agent himſelf is the only Cauſe of the Action: and to confound the Motive with the Agent or Cauſe of Action, muſt be extremely abſurd and unphiloſophical.

BUT tho the Motive is not, perhaps, abſolutely neceſſary to the Action it ſelf as ſuch, becauſe for any thing that appears to the contrary, an Agent may act abſolutely without a Motive; yet ſome wiſe and reaſonable Motive or End of Action, is certainly neceſſary to all wiſe and reaſonable Action. To act without a Motive, would be the ſame thing in effect as not to act at all: that is, ſuch an Action could anſwer no farther or better

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end than not acting: and consequently the Action, as well as the Agent, would be so far perfectly insignificant, redundant, and useless. He who should have no Object at all of his Love or Aversion, Hope or Fear, Joy or Grief, must be simply and purely indifferent to all Action; and consequently must be either in a state of perfect Rest and Inaction, or at least in a state equivalent to it, and in which the Actions of such a Being could be of no more signification or consequence, than the uncertain fluctuation of an Atom, or the whivering of a Feather in the Air: and therefore we cannot think or speak of the Actions of the supreme Being, or God himself, without ascribing to him these Motives and Passions. And tho, as the Divines tell us, and as we must undoubtedly believe, these Passions, and Motives of Action are ascrib'd only metaphorically, analogically, or figuratively to God, and cannot strictly and properly belong to a Being absolutely perfect; yet this plainly shews what the Springs of Motion are in our selves, and that we can find no other principle or ground of Action, by reflecting upon the Operations of our own Minds.

Now this great Spring of Action, or Principle of intelligent Motion, is in one word the *Desire* of Happiness; from which all the Passions arise, and of which they are but the various and different Determinations or Modifications, according to the various and different

rent Appearances, Positions, and respects of the Object.

THUS, that I may give some Instances, the Desire of any thing under the apprehension and appearance of its goodness, suitableness, or necessity to our Happiness, constitutes the Passion of Love: but the Desire of eschewing or avoiding any thing, as apprehended to be mischievous, hurtful, or destructive, constitutes the Passion of Hatred, or Aversation. The desire of any Good, which appears at the same time probable and in our power, constitutes Hope; but if the Good we desire appears improbable, difficult, or impossible, it accordingly constitutes Fear and Despair. The desire of regaining any lost Good is Grief; and the unexpected Gratification of Desire is Joy: The desire of Happiness to another under Pain or Suffering, is Compassion; and the desire of another's Punishment, Misery or Suffering, beyond the reasonable end and necessity of the Suffering it self, is Revenge or Malice; which is a Passion absolutely evil, and where it governs and prevails, it constitutes a Being perfectly and completely wicked, hurtful and destructive, such as can be only the just Object of Aversation and Hatred.

IT would be needless to give any more particular Instances in this Case, since, as I have said, I intend not here an exact methodical System of the Passions, but only to consider them, so far as they come within

my profeſs'd Deſign: but what has been obſerv'd may, I preſume, be ſufficient to ſhew, that the ſeveral Paſſions are nothing elſe but the various, determinate, and objective Modifications of that natural, neceſſary, and invincible *Deſire* of Happineſs, which is to us, at leaſt, under our preſent Circumſtances, the great and only Spring, Weight, or Movement of intelligent Action.

It may be proper in the next place to obſerve farther, that this *Deſire* of Happineſs is a certain painful Senſation, or uneaſineſs of the Mind, under a ſort of *Stimulus*, craving Appetite, or apprehenſion of ſomething ſtill wanting: For whoever will obſerve the Matter nicely, muſt find that there is always juſt ſo much of Pain or Uneaſineſs under any preſent Circumſtance, as there is of Deſire to get rid of it, or exchange it for ſome other; and ſuch a painful *Stimulus*, or uneaſineſs of Deſire as this, is, as far as we can apprehend, plainly neceſſary to all imperfect Beings, that are capable of a continual Growth and Improvement of Happineſs and Perfection: for we cannot conceive that any thing leſs could be a ſufficient Motive, Provocative, and Incitement to ſuch continued Action, as is neceſſary to the continu'd uninterrupted Purſuit of thoſe farther and farther degrees of Happineſs that are ſtill attainable. Perfect Pleaſure, without any compoſition or mixture of Pain, is perfect Happineſs; and muſt therefore be peculiar to that

Being

Being who is absolutely perfect, and consequently uncapable of any farther additional Acquisitions. I am oblig'd here frequently to interspersе such Cautions and Restrictions, because I would not have what I say in describing human Nature to be apply'd to the supreme Being, or God himself, of whose modify'd Actions and state of Happiness we cannot judge.

To proceed therefore, it must be observed farther, that in consequence of the several Judgments we form concerning Good and Evil, under the various respective Appearances and Considerations of the Object, the motive Organs, or nervous elastick *Fibrillæ*, are impress'd or stimulated after a certain particular and determinate manner; such as is peculiar to the particular respective Judgment or Consideration of the Object: and in this case the Sensation excited in the Mind, and the particular Modification of Motion impress'd upon the Organs are certainly reciprocal, and follow mutually from each other, whether the Impression be suppos'd to be first made upon the Body or upon the Mind: that is, any strong, violent, and preternatural Impression of Motion upon the Organs, will excite a painful Sensation in the Mind; any such painful Sensation, supposed to be first excited in the Mind from the bare intellectual Consideration of the Object, will consequently impress a strong, violent, and preternatural Motion upon the respective Organs. Thus

alſo any ſoft, eaſy, and placid Undulation impreſs'd originally by the actual impulſe of Objects upon the Organs, will excite a pleaſurable Senſation in the Mind; and after the ſame manner, a like pleaſurable Senſation being originally excited in the Mind, from the mere intellectual Contemplation of Objects, and without any material Action of the Object at all, will be follow'd with a like ſoft, eaſy, placid Undulation of the Organs: and by this inſeparable Connexion eſtabliſh'd by a Law of Nature, the Body and Mind are mutually impreſs'd, and act reciprocally upon each other. But if it ſhould be here ask'd how this mutual Communication is brought about, after what manner it is done, or whence it proceeds? I would fain know how Motion is communicated from one Body to another by impulſe? how Matter attracts Matter at a diſtance, and without any Impulſe or intermediate Contact at all? or how the ſame quantity of Motion, abating external Reſiſtance, is continu'd and propagated *in Infinitum*, when the viſible Cauſe ceaſes after one ſingle inſtantaneous Act? And when any Man can explain any one of the Laws of Nature, I will undertake to explain all the reſt: but in the mean while it will be ſufficient to lay down and evince any ſuch Law of Nature as moſt certainly true, and evident in Fact; and they who cannot think fit to reſolve them all into the original Will and continu'd Agency of the firſt Cauſe, may invent

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as many other intermediate and imaginary Cauſes as they pleaſe; but after they have gone a great way about, they muſt perhaps return at laſt to the ſame Point, or never come to any iſſue at all: and for my own part, I cannot imagine what Men ſhould mean by a Law of Nature, but the continued regular Operation of the firſt Cauſe, or Author of Nature, acting conſtantly and uniformly, after this or that particular manner.

I SHALL proceed therefore to lay down in this Caſe what I find to be plain in Fact, and to draw ſuch Conſequences from it as I apprehend moſt neceſſary to the preſent Purpoſe; leaving others to ſearch farther into the deep and hidden Springs of Nature, and to explain its Laws in the beſt manner they can, without the help of a firſt Cauſe.

'TIS therefore plain in Fact, that the painful Paſſions, as well as bodily Pain, impreſs the motive Organs, or nervous elaſtick *Fibrillæ*, with a ſtrong and violent Motion, which brings them alternately into ſtrong and forcible Contractions and Dilatations; or ſtrengthens and increaſes their muſcular Force and Action: now while this Pain or uneaſineſs of Deſire annex'd to the Paſſions, and with which the Nerves are thus impreſs'd, is moderate, and reſtrain'd within the bounds of Nature, either by a ſeaſonable and proper gratification of the Paſſion, or by the command and direction of Reaſon; ſuch moderately ſtimulating Deſires have a good effect,

as they ſtrengthen muſcular Motion, keep up the Circulation of the Blood, promote the natural and due Secretions, and excite a Man to ſuch Actions and Exerciſes, in which the animal Health, Life, and Vigor conſiſt. But where the Pain or Uneaſineſs annex'd to the prevailing Paſſion is too ſtrong and violent, and the Paſſion not ſeaſonably gratify'd, or not moderated and over-rul'd by Reaſon; ſuch a violent and continued *Stimulus* will gradually derive a too great quantity and proportion of Blood to the ſtimulated Organs; by which their Veſſels will be over-ſtretch'd, tumefy'd, and diſtended, their muſcular Force weaken'd and gradually impair'd, the *Æquilibrium* of the circulating Blood and ſecreted Liquors interrupted and broken, and the whole Machine put out of order; and in conſequence of this, the mental Pain and *Stimulus* of Deſire, will be join'd and inforc'd with an obſtinately fix'd and complicated Train of bodily Illneſſes and Pains, from the neceſſary eſtabliſh'd Laws of Union and Communication between the Soul and Body.

While we are throwing off, or freeing our ſelves from the pain and uneaſineſs of Deſire annex'd to any Paſſion, we feel a very great and ſenſible Pleaſure, or agreeable Emotion; and the Organs hereupon falling into eaſy, uniform, placid Undulations, the too great Current and Fluctuation of the Blood towards them is diverted, and the *Æquilibrium* and natural Motion reſtor'd; and from hence

hence any ill Effects of an antecedent too forcible *Stimulus*, will in a certain degree and measure be naturally thrown off: but as soon as all the pain or uneasiness of Desire is perfectly remov'd, either by gratifying the Passion or over-ruling it, the Pleasure ceases, and terminates in mere Indolence, which disposes the Person to Rest or Inaction; till the return of some fresh Desires, stimulating to farther Action, renews the same Succession and interchangeable Series of Pains and Pleasures. And this is the Circle of animal Life; as the *Stimulus* of Desire throws off the Indolence of Rest, and excites to Action, so the Gratification moderates the Pain of Desire, creates a Pleasure at first, and then terminates in the former Indolence and Inaction, till fresh Desires returning, stimulate to farther Action, and continue the same Round.

Thus stands the Case in general; but I take this to be a matter of such consequence, that perhaps it may be proper here to be a little more distinct and particular: to which purpose I shall in the first place lay down the following Phænomena as matter of Fact and Observation.

1. Then, in the Passion of Love, where it is found alone, and not mix'd or join'd with any other very strong or sensibly prevailing Passion, the Pulse is equal and uniform, but somewhat more intense and strong than usual; the Act of Respiration is modify'd just after the same manner with the Pulse; the Per-

ſon feels a certain mild, ſweet, and pleaſing Heat or Warmth in the Breaſt; and the Digeſtion in the Stomach is ſomewhat quicker than ordinary, but eaſy, free, and natural.

2. In Hatred or Averſation, where the Paſſion is ſtrong and ſenſible, the Pulſe is weak, low, and unequal; ſometimes quick and tremulating, and then again ſlow and interrupted, and the Act of Reſpiration is modify'd much after the ſame manner; cold ſtreamings are felt in the Breaſt, mix'd with a certain ſharp pungent Heat; the Perſon is affected with Nauſeas and a Diſpoſition to Vomiting, and the Digeſtion of the Stomach is weak, ſlow, and altogether perverted.

This Paſſion, where it is become habitual and prevailing, induces great Weakneſs, a Conſtriction of the Bowels, a ſalt, watry Blood, Tumors and Indurations of the Spleen and Meſentery; and in ſhort, all ſorts of influent, ſcorbutick, and glandular Diſeaſes, as the Conſtitution is more particularly diſpoſed.

3. In any ſenſible emotion of Joy, the Pulſe is uniform and quick, but not ſo intenſe and ſtrong as in the Paſſion of Love; the Reſpiration is free and eaſy, but not ſtrong; and the Breaſt, in breathing, is retain'd rather in a ſomewhat raiſed Poſition than depreſs'd: the Perſon feels a grateful Heat, which beginning in the Breaſt, that is, in the Heart and Lungs, diffuſes it ſelf outwardly together with the Blood thro the extreme Parts: in this caſe, the digeſtive Action of the Stomach

mach is somewhat impair'd, and the Appetite lost. When this Passion rises very high, the Pleasure is too intense; upon which the Nerves fixing, and losing their Spring, the Pulse suddenly sinks, and the Person dies as in a Trance or Ecstasy. But Instances of this kind are very rare.

4. UNDER the Passion of Grief, the Pulse is weak and low; the *Oesophagus* and upper Orifice of the Stomach are strongly contracted, which render the Act of swallowing difficult; a certain cold, condensing Pain is felt about the *Oesophagus* and at the Heart, which diffuses it self in chilly Streams over the whole Body. When the Grief is moderate, the Appetite and Digestion are not much hurt by it, but sometimes the Appetite is better than the Digestion; and what is eaten with a seeming Hunger, cannot be well carry'd off, but lies hard and heavy upon the Stomach. But where this Passion is strong and violent, as being mix'd with Fear, and arising from the apprehended loss of some great irreparable Good, and thereby terminating in Despair, 'tis almost impossible to express the dismal effects of it: for by its violent *Stimulus* and forcible Contraction, it constringes and compresses the *Oesophagus*, Stomach, Intestines, and Mesentery; destroys the Appetite, constipates and shuts up the Lacteals, and cuts off the Communication between the Stomach and the Blood; and in this state, under extreme Anguish and Horror,

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it ſoon waſtes and melts away the Fleſh, reduces the Body to a perfect Skeleton, and the Perſon reſigns his Breath, and falls an emaciated Victim to the vengeance of the Paſſion, leaving nothing for the Worms but Skin and Bones.

5. HOPE is much of the ſame nature with Joy, and is only a particular Modification of it, and therefore need not be particularly inſiſted on here; but Fear, according to the different Reſpects and Conſiderations of the Object by which it is rais'd and impreſs'd, has very different and even contrary Effects.

WHERE the Deſire of any Good is join'd with the Apprehenſion of the greatneſs and excellency of the Thing deſir'd, and the impoſſibility of obtaining it, the Paſſion of Fear thus ariſing, is always mix'd with an unconſolable Grief, and ſo runs into Deſpair: and this being almoſt perfectly the ſame thing with that Species of immoderate exceſſive Grief already deſcrib'd in its Nature and Conſequences, what has been obſerv'd there, may be here alſo equally underſtood and apply'd.

BUT when the Fear ariſes from ſome imminent Danger, or apprehended preſent Deſtruction, and is at the ſame time attended with the hope or appearing poſſibility of eſcaping the threatning impending Danger, or deſtructive Evil, the Paſſion of Fear thus rais'd and impreſs'd, is the ſtrongeſt and moſt amazing of all the reſt; for this impreſſes the greateſt poſſible Energy and ſtimulating Force upon the

the Nerves, insomuch that a Man's Strength, Activity, and capacity of Motion, under any such sudden emergent Consternation or Fright, enable him to do things that are perfectly stupendous, and in a manner incredible. Every body knows how much the Actions of People on a sudden Surprize, exceed their natural Strength and Ability, or ordinary power of acting; for in this case the Desire of Self-preservation is impress'd, in the strongest and most forcible manner possible; and the Effects are answerable, and proportional to the Force and Energy of the motive *Stimulus*.

It may be here observ'd, that the prodigious Strength, or surprizing muscular Force and Energy of Mad-men, is owing to this Passion habitually and mechanically fix'd upon them, so as to prevail over all the power and command of Reason; for the ravingly Mad are always in a Fright, every body looks ghastly and formidable to them, they are possess'd with a deep severe Suspicion that all about them intend them Mischief, and wait but for an opportunity to destroy them; and therefore they rush upon any that come near them, or endeavour to take them upon a proper advantage and surprize, to cut them off, as apprehending it of absolute necessity for their own Preservation and Security: and therefore the Force, Resolution, and Hardiness of Mad-men, proceed not from true Courage, but from the utmost height and extravagancy of Fear, and a wrong Impression or Imagination

tion of imminent Danger and inevitable Deſtruction, which renders them deſperate: but when they are once thorowly ſubdu'd, and find themſelves under a ſuperior Strength, they ſoon diſcover their predominant Paſſion, for they will then quake and tremble, beg and ſubmit in the tameſt and moſt abject manner; and manifeſt all the Symptoms of an horrible and unconquerable Fear, which bears down and prevails over all the power and command of Reaſon.

FROM this account of the ſenſible Appearances or Phænomena of theſe Paſſions, or different Modifications of Deſire, the Nature and Mechaniſm of theſe and all the reſt may eaſily be accounted for and explain'd; to which purpoſe I ſhall here farther premiſe the following general Phænomena, as matter of Fact and Obſervation.

I. ALL the grateful or pleaſurable Paſſions, raiſe the vital Tide, ſtrengthen and quicken the Pulſe, diffuſe the natural Heat, and take off any antecedent *Stimulus*, Weight, or Preſſure upon the Abdomen and inferior Organs: but on the contrary, the painful Paſſions ſink and depreſs the Blood, weaken the Pulſe, recall and concenter the natural Heat, and fix a *Stimulus*, Weight, and Compreſſure upon the inferior Organs.

II. ALL the Paſſions impreſs their characteriſtick Senſations or Modifications of Plea-

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ſure and Pain, eſpecially upon the *Oeſophagus* and upper Orifice of the Stomach.

III. ALL the Paſſions diſcover themſelves by the different Modulation and Tone of the Voice, or the different Modifications of Motion which they impreſs upon the Muſcles of the Larynx.

IV. THE Paſſions alſo fix their characteriſtical Symptoms and Appearances in the Motion of the Eyes, the Air of the Countenance, and the Muſcles of the Face.

FROM theſe Obſervations it may be concluded, that the Nerves of the eighth Conjugation, or the *Par vagum*, are the principal Inſtruments of the Paſſions, by means of which they are variouſly impreſs'd, modify'd, and organiz'd: to make this appear, we need only to conſider the remarkable Diſtribution and Communication of thoſe Nerves, together with the neceſſary Conſequences of their different Impreſſions, and determinate Modifications of Motion; and then to apply this to the foregoing Phænomena of the Paſſions, by which they will be moſt eaſily and naturally explain'd.

'TIS well known to the Anatomiſts, that theſe Nerves take their original, together with nine other conjugate Pair, from the *Medulla oblongata*; the *Par vagum* having perforated the *Os occipitis*, ſends out Branches to the Pharynx and Larynx, with their ſeveral Muſcles; after which, in its progreſs, it

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is dispersed thorow all the parts of the Breast and Abdomen, and particularly it dispenses Sense and Motion to the Heart, Lungs, *Oesophagus*, Stomach, Diaphragm, Intestines, Liver, Spleen, Mesentery, Caul, Kidneys, and Bladder, and to the several Organs of Generation in both Sexes. But because the Branches and Ramifications of the *Par vagum* could not have dispensed sufficient Sense and Motion thro such a large and wide Course to so many complicated Bowels and Organs; therefore there is another Nerve form'd after an extraordinary manner, and which may be justly esteem'd the great Accessary or Assistant to this eighth Pair, or *Par vagum*: what I here mean, is the Intercostal Nerve, which has no particular distinct origination, either in the *Medulla oblongata*, or the Spinal Marrow, as all the other Nerves have, but is thus form'd. First, several Branches proceeding from the fifth, sixth, ninth, and tenth Pair of the *Medulla oblongata*, uniting with other Branches and Ramifications from the *Par vagum*, constitute this Intercostal, which afterwards in its progress downward, is reinforc'd with a multiplicity of small Branches from the vertebral and intercostal Nerves, which are sent out from the Spinal Marrow. The Intercostal thus formed, accompanys the *Par vagum* thro its whole Course, and sends out Branchings and Ramifications, together with those of the eighth Pair, to all the Parts and Organs above mention'd.

Now by this means the *Par vagum* communicates not only with the Nerves which proceed from the Spinal Marrow, but likewise with those which are the Organs of Sensation in the Brain, and which communicate Sense and Motion to the Eyes, Ears, Tongue, and Palate, and to the several Muscles of the Face, by which the Passions are naturally characteriz'd and expres's'd. I shall therefore call the *Par vagum*, with its several Branches and Ramifications, the Patheticks of the *first Order*; the Intercostal, under all its Divisions and Subdivisions, which are every where disseminated and interspers'd with the Branches of the *Par vagum*, the Patheticks of the *second Order*; the Nerves which serve the Muscles employ'd in Respiration, and which have the strongest Communication with those of the *Par vagum*, by means of the Intercostal, I call the Patheticks of the *third Order*; and the Nerves which immediately dispense Sense and Motion to the several Parts of the Head, and which have a weaker and more remote Communication with the *Par vagum*, by the mediation of those Branches of the fifth, sixth, ninth, and tenth Pair, which join the Intercostal, I call the Patheticks of the *fourth* or last *Order*.

ACCORDING to this Gradation, the Organs which are immediately supply'd with Nerves from the *Par vagum*, or Patheticks of the first Order, will be first affected in the Passions, and with the least degree of impres's'd

impreſs'd Motion; with which the Organs communicating immediately with the Intercoſtal keep pace, and are affected almoſt at the ſame time, and with the ſame impreſs'd Motion: in the next place, the Organs which are ſupply'd with the Patheticks of the third Order, or the Nerves employ'd upon the Muſcles of Reſpiration, are affected; and laſt of all, the Organs of Senſe and Motion in the Brain it ſelf, by which Senſation and Imagination are perform'd, are put into a ſtrong and forcible Emotion, by which the Operations of Senſe, Judgment, Imagination, and Reaſon are diſturb'd, and perverted in the ſtronger and more violent Paſſions. This gradual riſe and progreſs of the Paſſions, is confirm'd in fact by Obſervation and Experience; but how they are generated, and by what ſteps they make theſe advances, muſt be conſider'd a little farther.

It muſt be here then obſerv'd, that the quantity of Motion impreſs'd upon the Pathetick Nerves in any Paſſion, is always proportional to the ſtrength of the Deſire; that is, to the apparent greatneſs and neceſſity of the Good which we deſire to obtain, or continue the Enjoyment of: or, which is the ſame thing, the quantity of Motion impreſs'd, is ever proportional to the greatneſs and deſtructiveneſs of the Evil which we would guard againſt, or get rid of; for to get rid of any preſent, or guard againſt any future apprehended Evil, is a Good, in proportion to

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the greatneſs of the Evil that is remov'd or prevented.

But ſuch impreſs'd Motion is not always uniform, or equably communicated and diffus'd thro the whole pathetick Syſtem; for ſince the largeſt and moſt numerous Branches and Ramifications of the pathetick Nerves are ſpent upon thoſe Organs, which derive their Blood from the deſcending Trunk of the *Aorta*, as the Stomach, Inteſtines, Liver, Spleen, Meſentery, Pancreas, Kidneys, *&c.* upon any Motion too forcibly impreſs'd, or long continu'd, theſe inferior Organs are generally the firſt and greateſt Sufferers: For theſe inferior Branches and Diviſions of the pathetick Nerves, being larger and more numerous than thoſe above the Heart, 'tis plain they will be capable of receiving and retaining a greater quantity and degree of Motion, which in the ſtronger and more violent Impreſſions of the Paſſions, muſt break and interrupt the *Æquilibrium* of the circulating Blood: and the Blood flowing with impetuoſity, and in Fluctuations and irregular Surges to the ſtimulated Parts, thoſe Organs which are thus over-ſtretch'd and diſtended, muſt undergo a Senſe of Pain, Weight, and Oppreſſion; and by this means the Head and ſuperior Parts being depriv'd of their due ſhare and proportion of Blood, the Pulſe muſt ſink, the natural Heat diminiſh and retire, a Senſe of Cold and Conſtriction will be felt about the *Oeſophagus*, where the Branches of

the *Par vagum* are very numerous, and the Perſon will ſigh, groan, moan, cry out and complain, and diſcover in the Tone of the Voice, and Modulation of the Muſcles of the Larynx, the characteriſticks of the prevailing Paſſion.

THIS is the ſtate of Nature under the painful depreſſing Paſſions, which ariſe from a ſtrong Deſire, join'd with an appearance of Improbability, great Difficulty, or Impoſſibility of obtaining or ſecuring the Good deſir'd; but where the Deſire is attended with an appearance of Probability, or facility of obtaining or effecting the thing deſir'd, this pleaſing appearance of Probability, by moderating the Pain of the Deſire, and taking off the too great and violent Action of the pathetick Nerves upon the inferior Organs, will throw the whole pathetick Syſtem into a ſtrong, but eaſy, natural, equable, and uniform Undulation; by which the *Æquilibrium* of the Blood being reſtor'd, the invigorating pleaſurable Paſſions of Love, Joy, Hope, *&c.* will be raiſed: and in this Caſe the Pulſe riſes, the natural Heat is diffus'd; and by the Action of the pathetick Nerves upon their proper and reſpective Organs, the ſeveral Symptoms are produced, which diſcover their placid Emotion, under the agreeable Appearance of the Object.

BUT the ſtrongeſt and moſt univerſal Impreſſion of Motion upon the Nerves, ariſes from ſome extremely keen and ſharp Deſire, join'd

join'd with the Appearance of probable Succeſs, under the neceſſity of acting for Self-preſervation, or to avoid ſome apparent or apprehended preſent Deſtruction. The prodigious and ſurprizing Force or Energy which a ſtrong ſtimulating Deſire under theſe Circumſtances impreſſes upon the Nerves, would be altogether incredible, were we not ſufficiently convinced of it from the Actions of Mad-men, and of People in a Fright.

In this caſe the *Stimulus* of Deſire being exceeding ſtrong, and the conſequent impreſs'd Motion univerſal, the pathetick Nerves of the fourth and laſt Order come to be affected; that is, the Organs of Senſation and Imagination in the Brain are brought into ſuch ſtrong and violent Vibrations or Undulations, as to diſturb and pervert all the Operations of Reaſon: for, from this violent Perturbation of the pathetick Nerves in the Head and Brain, Mad-men have their Imagination as ſtrong and vivid as Senſation it ſelf; what they imagine, they ſee and hear; and the Impreſſions are equally ſtrong, and the Appearances the ſame, as if their Organs were immediately ſtruck by the Objects themſelves: they who contradict them, or endeavour to convince them that the Objects of their Imagination are not real, ſeem as abſurd and unreaſonable to them, as if they call'd in queſtion the truth of their Senſes, or deny'd the exiſtence of preſent viſible Objects; and for this Reaſon they generally hate moſt their

beſt Friends, and ſuch as they had the greateſt Reſpect for before, becauſe they endeavour to perſuade them out of their imaginary, and to think and act upon common Principles, which yet is impoſſible. In the mean while, this ſtrong and deep attention to the Objects of their Imagination, takes them off from what is really exiſtent and about them; they ſee and judge of nothing as it really is, or as other Men do, but every thing looks new and odd, ſtrange and ſurprizing to them. In ſhort, by the ſtrength of their Paſſions, their Imagination prevails over their Senſes; and perhaps the State they are in, cannot be better deſcrib'd, than by calling it a waking Dream: for when they recover, they look back upon what paſs'd in their Madneſs, as a Man when he awakes reflects upon the Images and Repreſentations of his Dream.

FROM theſe violent efforts of the Senſorys and motive Organs in the Brain, the Blood flows continually with impetuoſity and irregular Surges to the Head, and is again thrown off as faſt by the ſtrong and forcible Action of the Nerves. This Emotion and Perturbation being maintain'd by the continued *Stimulus* of the Paſſions, and ſtrengthen'd and confirm'd by the Heat and Efflatus of the Blood in the carotid and cervical Arterys, the vital Tide is by this means raiſed, and inceſſantly kept up againſt the weaker Efforts of the inferior Organs below the Heart: and from hence it comes about, that Mad-men do

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not need thoſe periodical returns of Sleep and Reſt, to raiſe and recover the *Æquilibrium* of the Blood, which are neceſſary to others; but on the contrary, they can watch almoſt continually, bear the extremes of Heat and Cold, and undergo the moſt violent Efforts of continued Motion, without any Senſe of Pain, or being at all depreſs'd, diſpirited, or fatigued.

Now from hence we may obſerve the two contrary Extremes of the invigorating and debilitating Paſſions; the one riſing up at laſt into a *Mania*, or raving Madneſs, and the other ſinking into a hypocondriack Melancholy: the principal Seat of the one is the Brain, and of the other the Viſcera of the Abdomen, eſpecially the Spleen and Meſentery. The one inflames and over-heats, the other chills and froſts the Imagination: the one hangs over the Underſtanding like a glaring, dazling, infatuating Light, which darts like flaſhes of Lightning thro the Machine; the other like a thick, black, and diſmal Cloud, that ſinks all the Powers of Nature into the Depths and Horrors of Miſery and Deſpair.

From what different Impreſſions and Modifications of Motion upon the Nerves, theſe two oppoſite Conſtitutions of raging Madneſs, and hypocondriack Melancholy are produced, will be eaſily underſtood by what has been ſaid already; but it may be of conſequence here to obſerve their different Effects, by a

long continuance upon the Organs, and the Diſeaſes they at laſt produce, by which the Paſſions, to which they owe their original, are farther ſtrengthen'd, radicated, and confirm'd.

Now the Blood having been long depreſs'd, and determin'd with too great an Impetus and Weight downward to the Viſcera of the Abdomen; theſe Viſcera, by an Over-ſtretch and Diſtenſion, muſt at laſt come to be obſtructed, tumefy'd, and ulcerated by a thick, ſalt, viſcid, and coagulated Lymph, or Serum lodg'd upon the Glands: that is, thoſe Organs will be affected with a fix'd, confirm'd Scurvy. In which caſe, tho the Spleen and Meſentery generally ſuffer firſt, yet the other Viſcera, particularly the Liver, Caul, Pancreas and Kidneys, often ſhare their Parts, and come to be affected after the ſame manner. Now by ſuch a *Stimulus*, which muſt be occaſion'd by the tumefy'd, indurated, or ulcerating Glands in theſe Viſcera, the Blood muſt be continually depreſs'd, and the vital Tide kept low, which muſt farther fix and ſtrengthen all the painful debilitating Paſſions, and confirm the Habit. And indeed, from this Cauſe alone, the hypocondriacal Melancholy is often produc'd, without any antecedent Irregularity or Diſorder of the Paſſions to bring it on: Theſe Conſtitutions therefore mutually generate, ſtrengthen, and nouriſh each other.

In like manner, the exorbitant Paſſions and mental Perturbations of the other Claſs, which too highly raiſe and exalt the Blood, and terminate in Madneſs, come at laſt to fix the ſame ſcorbutick Taint upon the cerebral Glands and Lymphaticks of the Brain; and then the *Stimulus* of the Paſſions having this additional material *Stimulus* of an hot bilious Serum fix'd upon the lymphatick Glands, the ſame pathetick Outrage will be hereby farther ſtrengthen'd, and the Madneſs confirm'd. And in this Caſe alſo the mental *Stimulus* of the Paſſions, and the material ſcorbutick *Stimulus*, will mutually generate each other: for as Madneſs brings on a cerebral Scurvy, which without ſeaſonable help at laſt kills; ſo a cerebral Scurvy produces a true and real Madneſs, without any antecedent Diſorder in the Mind.

From the Principles already laid down, all the foregoing Phænomena of the Paſſions, with any other that might occur to Obſervation and Experience, might eaſily be accounted for in particular; but that would draw out this Propoſition to an unreaſonable and unneceſſary Length, and I doubt not but the intelligent Reader will eaſily apply what has been ſaid in general to the particular Caſes to which it may belong: and therefore I ſhall only add farther a few general Corollarys from what has been here advanc'd, by which the Doctrine of the Paſſions may be

render'd more universally useful, so far as it relates to the Province of Physick.

1. FROM what has been observ'd, 'tis plain that People of the softest and most delicate Constitutions, and such whose Nerves are most easily impress'd, and which are most susceptible of Motion, must be chiefly subject to the strength and violence of the Passions; and therefore Women and Children are generally more subject to Passions than Men; and they exert their Rage and Tyranny upon Men, in proportion to the tenderness of their Constitutions, and the weakness of their Judgments. But they who have the Care and Management of Children, ought especially to guard them as much as possible against the Attacks and Impressions of the Passions; for tho the Passions may seem innocent and diverting at first in Children, before they have strength or skill enough to do much harm with them; yet by growing up with them, fixing their Characteristicks and Impressions upon the Constitution, and being sown as it were in the first Rudiments of Nature, they still gain strength with years, and soon become infinitely mischievous.

2. FROM hence we may see, that a sound Mind, a clear Head, and a well-settled Judgment, a just Acquaintance with human Nature, and a right Notion of human Life, are the best guards and defence against the hurtful destructive Passions: for the Passions being constantly and universally in all their Modifi-

cations,

cations, whether good or bad, annex'd to the several Judgments we form concerning Good and Evil, 'tis certain they are never injurious, hurtful, or mischievous, but when they proceed from a wrong Judgment. The wretched Mistakes which Mankind are apt continually to run into concerning Life, Pleasure, and Happiness, are undoubtedly the true ground of all the exorbitant Passions and their destructive Consequences: A Man, without being over-religious, might be easily convinc'd that Pride, Ambition, Malice, Revenge, Avarice, Sensuality, and the like vicious irregular Desires, can never be quieted or tamed by Gratification; they are always strengthen'd, fed, and nourish'd by their Objects, till the predominant Passion becomes an absolute uncontrolable Master, and destroys a Man's Reason, Judgment, and Health, together with his Virtue. Nothing can lay these evil Spirits, or appease their Vengeance, but a resolute Self-denial, by keeping the Passions continually under the Curb and Restraint of Reason; and a Man is never hurt by them, till he sacrifices his Understanding, and gives himself up to the Pleasures and Happiness of a Beast or a Devil.

But among all the exorbitant Passions, that Rage, Fear, and Grief, which enter into the Constitution of Superstition and false Religion, are the most hurtful and destructive to the particular Persons themselves, as well as to Mankind in general. All Impostors have been

been ever ſenſible of the Power of Fear in Religion, and have contrived their Syſtems accordingly; Vengeance without Mercy, inexorable Revenge to be executed upon all Adverſarys and Gainſayers, as it is the Character of a Being perfectly Cruel, Miſchievous, and Wicked, ſo it is the Image in which all Impoſtors have ever affected to dreſs up and repreſent their Deity: and from hence it happens, that they who are once thorowly devoted and enſlav'd to any ſuch Scheme of falſe Religion or Superſtition, preſently loſe their Underſtandings, and become Maniacks, or Hypocondriacks: 'Tis their buſineſs to fight in the dark, and to kill and deſtroy themſelves and one another, to gratify the Malice of their God, and complete the Merit of their Divinity. Such a Religion, whatever its Pretence be, is moſt certainly Diaboliſm; and the God that Men worſhip by Rage and implacable Revenge, under the grievous Fears and Apprehenſions of his Power only, without Wiſdom or Goodneſs, is no other than the Devil.

3. We may conclude likewiſe, from what has been here obſerved and advanced, that nothing is more neceſſary to keep the Paſſions under the Moderation, Government, and Command of Reaſon, than continual Employment and Exerciſe, in the purſuit of ſome great, generous, and vertuous End: by this alone a Man will be capable of anſwering the deſign of his Being, and of ſecuring

to

to himſelf all the innocent and valuable Pleaſures and Enjoyments of Nature. All the Paſſions come with their full force upon the Idle, as having nothing to divert or bear off the blow; but when they find a Man otherwiſe employ'd, they miſs their mark, and either never affect him at all, or ſtrike him but weakly, at random, and with a force that is eaſily directed another way. In ſhort, Buſineſs is the true Elixir of Health, for the Mind as well as for the Body, and one of the greateſt and moſt ſovereign Preſervatives againſt deſtructive Paſſions and Diſeaſes.

The End of the SECOND PART.

Philo-

Philosophical Principles of MEDICINE

PART I

Containing the Primary Affections of Solids and Fluids: Chief Indications of Medicine, Theorems, Problems, Corollaries, Propositions, Cases, Cures, Observations, Queries, Digressions, Explications, Demonstrations, Solutions, Dilucidations, Proposed and Mechanically resolved.

PROPOSITION I.

TO explain the manifold Operations, Affections, Diseases, Symptoms, Crises, Paroxysms, Periods, Recidivations, Complications, Dependencies, Sympathies, Antipathies, Consents, Dissents, Contrarieties, Specifics, Idiosyncrasies, Critical Days, Prognostics, Diagnostics, Aphorisms, Coacervations, Dissipations, Solutions, Coagulations, Fermentations, Effervescences, Ebullitions, Precipitations, Sedimentations, Depurations, Separations, Secretions, Excretions, Evacuations, Retentions, Suppressions, Obstructions, Inflammations, Erysipelas, Phlegmons, Gangrenes, Sphacelus, Tumors, Ulcers, Fistulas, Hæmorrhoids, Hæmorrhages, Fluxes, Lasks, Vomitings, Nauseas, Hiccoughs, Convulsions, Spasms, Cramps, Contractions, Relaxations, Tremors, Palsies, Apoplexies, Lethargies, Coma's, Vigilies, Syncopes, Vertigos, Megrims, Head-aches, Pains, Aches, Stupors, Numbness, Titillations, Itchings, Shiverings, Horrors, Rigors, Cold and Hot Fits, Sweats, Faintings, Defluxions, Rheums, Watchings, Dreamings, Nightmares, Madness, Melancholy, Hypochondriacism, Hysterics, Appetites, Longings, Loathings, Indigestions, Crudities, Vitiosities, Corruptions, Impurities, Putrefactions, Colliquations, Consumptions, Atrophies, Marasmus's, Tabes's, Leanness, Fatness, Bulk, Weakness, Strength, Agility, Pleasure, Pain, Ease, Trouble, Health, Sickness, Life, Death, and all the Phænomena, Symptoms, Affections, Changes, Events, Contingencies, Effects, Operations, Productions, Generations, Corruptions, Alterations, Mutations, Conservations, Destructions, Annihilations, Resurrections, Transmigrations, Transformations, Transcendencies, Transfigurations, Transmutations, Transfusions, Transplantations, Transpirations, Transitions, Transactions, Transgressions, Transmissions, Transparencies, Translations, Transubstantiations, Transcolations, Transfixions, Transpositions, Transversions, Transformations, Transcriptions, Transfretations, Transmigr

Philoſophical Principles

OF

MEDICINE.

PART III.

Containing the primary and chief Intentions of Medicine in the Cure of Diſeaſes, Problematically propos'd and Mechanically reſolv'd.

PROPOSITION I.

TO explain the morbifick Conſtitutions, as depending on the different State and Diſpoſition of the Blood.

THE Blood differs in different Perſons, and in the ſame Perſon at different Times, with reſpect to its Quantity, Velocity, Fluxi-

Fluxility, Denſity, Seroſity, Solubility and Direction, or particular Determination.

'Tis difficult to determine exactly the abſolute quantity of Blood in a human Body; but 'tis certain that this Quantity muſt be much greater than has been commonly ſuppoſed, and that all the Trials made by bleeding ſeveral Creatures to death, and computing the quantity of Blood in other Bodys, in proportion to the Weights, muſt be fallacious: for 'tis probable that at leaſt $\frac{2}{3}$ of the quantity of Blood contain'd in an animal Body, is continually paſſing the Capillarys and ſmall Veſſels in the glandular and muſcular Fleſh: and this Blood can never be drawn off by any quick Diſcharge from cutting the large Veſſels; for in this caſe, the large and open Veſſels are empty'd faſter than they can be ſupply'd, and fill'd again from the capillary and ſmall Veſſels; and the large Veſſels being empty'd, from the conſequent Defect of Blood at the Heart, the Animal falls into Convulſions and dies, and the Circulation ſtops, while the far greater Part of the Blood muſt be ſuppos'd to ſtagnate in the ſmall Pipes and Capillarys.

Besides, it cannot be doubted but the natural and due quantity of Blood is very different in different Conſtitutions, and under the various Circumſtances of animal Life. Women and Children have proportionally more Blood than Men; and in general, the

more ſoft, delicate, and tender the Conſtitution, the greater is the quantity of Blood and Fluids in proportion to the Solids.

But this is a Speculation of no great conſequence; for tho the abſolute Quantity is hard to be determin'd, yet the relative Quantity, as redundant or defective, may eaſily be diſcover'd; and this is all that the Phyſician is concern'd about. And here the Symptoms of Exceſs or Defect, of an over-Repletion or Depletion in the Blood-Veſſels, are ſo very obvious, that they need not particularly be inſiſted on; only one thing it will be neceſſary to remark, that a Phyſician ought to be very cautious that he does not miſtake every occaſional Fluſh or Tide of the Blood to the Head, for a general Plethora of the Blood-Veſſels: for theſe Tides and Fluſhings are very common in many Caſes, where there is yet no Blood to ſpare; and in which whenever Bleeding is haſtily reſolv'd upon, it is certainly attended with future ill Conſequences, much greater than the preſent Benefit receiv'd.

The morbifick Exceſs, or Defect of the Blood's Velocity, is as remarkable as that of its Quantity; but this can only be judg'd of from the natural ſtate of the Pulſe in Health, which is different in different Conſtitutions: the ordinary number of Pulſations in a Minute, is from 70 to 80, under a ſtate of Waking and moderate Heat; and from 80 to 96, during the time of Sleep.

The

THE Velocity of the Blood (to which its *Momentum* is proportional) is ever in a Ratio compounded of the frequency of the Pulſe, and the magnitude or quantity of the Stroke: and conſequently when the number of Pulſations in a given Time, and the quantity of the Stroke are reciprocally proportional; or where one is increas'd as the other is diminiſh'd, the Velocity will remain the ſame. 'Tis well known that a certain Quantity of Blood thrown into the Arterys at every Syſtole or Contraction of the Heart, occaſions the Pulſe: now this quantity thrown into the Arterys at every Contraction of the Heart may be greater or leſs, while the number of Pulſations in a given Time, or the frequency of the Pulſe continues the ſame: From whence 'tis evident, that the Blood may move ſwifter or ſlower thorow the Veſſels; that is, the Velocity may be greater or leſs, while the number of Pulſations is the ſame. But tho the diſtance between the Pulſations may not be alter'd, yet the magnitude of the Stroke or ſtrength of the Pulſe, muſt neceſſarily be proportional to the quantity of Blood thrown into the Arterys; by which the Sides of their Veſſels are driven outward, and which is the only Cauſe of the Pulſe. On the other hand, where the quantity of Blood thrown into the Arterys at every Syſtole continues the ſame, the abſolute Quantity paſſing in a given Time, muſt be proportional to the frequency of the Pulſe, or the number of Pulſations in the

Time given: and therefore the abſolute Velocity muſt be proportional to both theſe conjunctly, or in the Ratio compounded of the frequency of the Pulſe, and the magnitude of the Stroke.

It is therefore a great miſtake in thoſe who judge of the Velocity of the Blood only by the Frequency or Quickneſs of the Pulſe, as if a quick Pulſe always indicated an increas'd Velocity; and *vice verſa:* and conſequently they have been much miſtaken, who have defin'd a Fever by an increas'd Velocity of the Blood; for nothing can be more manifeſt to Experience than this, that the Velocity of the Blood may be increas'd extremely without a Fever: and on the contrary, this Velocity, during a Fever, is often very much diminiſh'd, as appears from the weakneſs of the Pulſe, tho it may be very quick, and even tremulating.

There is one very remarkable difference of the Pulſe, which it may be neceſſary to obſerve here; and that is the Diſtinction between a large or full, and a thin or ſmall Pulſe: either of theſe may be ſtrong or weak, and by a reciprocal Proportion may ſo balance each other, as to retain the ſame magnitude or quantity of the Stroke in both; that is, the Velocity of the Blood under a large, full, and weak Pulſe, may be the ſame as under a ſmall, but ſtrong and ſmart Pulſe.

THE Coats of the Veſſels being ſometimes very much diſtended by the great quantity of Blood thrown into the Arterys at every Syſtole, the Pulſe hereby becomes ſlow, and the Blood waves or undulates thro the Veſſels, in a full, ſwelling, but ſlow Tide. This is commonly the lethargick and apoplectick Pulſe; and the ſame kind of Pulſe diſcovers it ſelf in the pleaſurable Paſſions, eſpecially thoſe of Love and Joy, when very ſtrong and ſenſible; and in a very ſudden exceſſive Emotion of Joy, the Pulſe riſes and ſwells extremely, and then ſinks all at once, and the Perſon ſometimes expires in a *Deliquium*.

ON the other hand, a very thin and ſmall Pulſe is often extremely ſmart and ſtrong, and the Blood is driven ſwiftly forward, while the contractive Power of the Nerves is very great, ſo as to reſiſt any great Diſtenſion or Enlargement of the Blood-Veſſels: And this ſort of Pulſe may generally be obſerv'd in Mad-men, and in thoſe who acquire an extraordinary Strength and Activity, when made deſperate by a Fright, or ſet upon Action by the appearance of ſome preſent preſſing Neceſſity for Self-preſervation.

3. ANOTHER different State or Diſpoſition of the Blood, is its greater or leſs degree of Fluxility and Viſcidity: 'tis manifeſt that the Blood, on the one hand, may have its parts too intimately ſeparated, divided, attenuated and fluxiliz'd; or on the contrary, there may be a too ſtrong and cloſe Coheſion

of the Parts of the Blood, so as to render the Mass extremely thick, viscous, and tenacious. The first of these morbifick Constitutions disposes the Blood to a too quick, easy, and rapid Motion, and sometimes dissolves and fuses it to such a degree, that the Globules or *Crassamentum* passes together with the Serum thro the glandular Strainers, and occasions bloody Secretions, as in malignant and pestilential Fevers: but the other viscid cohesive state of the Blood, renders it unapt for Motion, and disposes it to stick and lodge upon the Capillarys, and glandular Lymphaticks or Aqueducts.

4. ANOTHER different State or Constitution of the Blood depends on its specifick Gravity, or the various degrees of its Rarefaction and Condensation. This Constitution depends entirely on the several degrees of Heat in the Blood; for as the natural Heat rises too high or sinks too low, the Blood will in consequence be either too much rarefy'd or too much condens'd: and the consideration of this is of such importance, that a Physician can do nothing as he ought without it. For in the former Case, where the Blood is over-heated and rarefy'd, the expansive Force of the elementary Fire and Air contain'd in the Mass, prevails over the corpuscular Attraction; and then by the coagulating Power of Heat upon the Serum, and its too intimate Mixture and Cohesion with the *Crassamentum*, the Lymph which should

form the Secretions, cannot be ſeparated, but the Serum is as it were abſorb'd, imbib'd, or ſuck'd up in the *Craſſamentum*; in conſequence of which, the natural Secretions muſt neceſſarily be diminiſh'd.

Now in this caſe, if the expanſive Force of the heated rarefy'd Blood be too ſtrong for the contracting reſtitutive Power of the Nerves, as it uſually happens, this muſt break and deſtroy the *Æquilibrium* of the circulating Blood; and the *Æquilibrium* being thus broken, and the lymphatick Secretions at the ſame time extremely leſſen'd, or quite ſuſpended, a Fever muſt enſue, of ſome ſort or other, and more or leſs inflammatory, according to the degrees of Heat in the Blood, and conſequent Suſpenſion or Interruption of the lymphatick Secretions. But if by means of ſome violent Paſſion, or other *Stimulus* upon the Nerves, their contracting reſtitutive Power is kept up and maintain'd, ſo as ſufficiently to reſiſt the expanſive Force of the heated rarefy'd Blood; the Lymph in this caſe will paſs off in a greater Quantity, tho in a Quantity leſs than what is natural, the conſequence of which will be a *Mania* or Madneſs, which is Phrenſy or Delirium without a Fever.

The oppoſite Conſtitution to this, is where the Blood is immoderately cool'd and condens'd; in this caſe, the corpuſcular Attraction prevails over the expanſive Force, and the Serum hereby being over-thinn'd and fluxi-

fluxiliz'd, is ſeparated too faſt, and thrown off in immoderate Quantitys upon the Glands and Lymphaticks: Now from hence, if upon any occaſion the urinary Drains happen to be obſtructed, a ſurcharge of Serum upon the Glands and Lymphaticks muſt ſoon be the conſequence, and a Dropſy will enſue. But in caſe the fluid Parts of the Urine paſs freely enough, and only the groſſer Recrements, Salts, and Sabula are kept back, theſe, being thrown upon the ſeveral Organs, ſometimes in one Part and ſometimes in another, will produce the ſeveral Symptoms and Appearances of the Scurvy; which morbifick Conſtitution having been conſider'd already, *Prop.* 13. *Part* II. I need not farther inſiſt on it here. And how this morbid State may raiſe and bring on the ſeveral Species and Phænomena of ſcorbutick or glandular Fevers, has been already, as I preſume, at leaſt ſufficiently explain'd.

FROM all which I may make this general Obſervation; That 'tis a thing of great conſequence to a Phyſician, not only in Fevers but in all other Diſeaſes, to watch carefully the various Turns and Interchanges of Nature with reſpect to Heat and Cold, upon which the preſent ſtate and diſpoſition of the Blood, as to Rarefaction or Condenſation, will depend; and as one or the other of theſe ſhall happen to prevail, whether conſtitutionally or by accident, ſo the general Method ought accordingly to be either cooling,

refrigerating and condenſing, or warming, raiſing, and invigorating. But,

5. THE State and Conſtitution of the Blood differs alſo with reſpect to its Seroſity and Oleoſity; that is, with regard to the different quantity and proportion of the Serum and *Craſſamentum* in the mix'd Maſs.

THE *Craſſamentum* which ſubſides in the Porringer when Blood has been drawn off, is generally $\frac{1}{2}$ of the whole Maſs, or equal in Quantity to the Serum which ſwims above it; this is its moſt natural and ordinary Quantity, and where it is found in a proportion very different from this, whether in Exceſs or Defect, the Conſtitution becomes morbifick. And becauſe the principal Heat, Vigor, and Efflatus of the Blood conſiſt in the *Craſſamentum*, by reaſon of the great Proportion of Oil and volatile Salts with which it abounds; therefore from the proportion of the *Craſſamentum* to the Serum, the heat of the Conſtitution may be judg'd of: which is either greater or leſs, exceſſive or defective, according to the greater or leſſer quantity and proportion of the *Craſſamentum* in the Blood. 'Tis true indeed, that where the quantity of the *Craſſamentum* in proportion to the Serum is very great and exceſſive, and but little Serum will ſeparate from the Blood by long ſtanding; the Conſtitution will be weak, and all the animal Powers low and languid: yet ſtill a continual troubleſom Heat, great difficulty of Breathing, and hot, ſuffocating, inflam-

flammatory Pains coming on by any little Motion or Exerciſe, will be the conſtant Symptoms and Indications of ſuch a ſtate and diſpoſition of the Blood.

On the other hand, an exceſſive quantity of the Serum, in proportion to the *Craſſamentum*, brings on, or diſpoſes to all thoſe Diſeaſes which are attended with a ſinking, languid, debilitating coldneſs of Conſtitution.

6. By the Solubility of the Blood, I underſtand that Quality or Tendency in the Serum and *Craſſamentum*, by which they are diſpoſed to ſeparate and diſengage from each other, when the Blood comes to ſtand and cool in a Baſon or a Porringer. 'Tis well known that when Blood is taken off, it muſt frequently ſtand a long time at reſt, and in a cold place, before its Principles can diſunite ſo as to effect a perfect ſeparation of the Serum from the *Craſſamentum*; and yet at laſt, when the Separation is made, there may be a ſufficient quantity of Serum, and perhaps a greater proportion than ordinary; whereas at other times, this ſeparation ſhall be quickly made, and the Solution effected after a ſhort time of ſtanding and in a warmer Air.

Every one muſt have obſerved theſe different Phænomena in the Separation or Solution of the Serum and *Craſſamentum*; and the principal Reaſon of this difference, is plainly the different Degrees of Heat to which the Blood is ſubject, the Globules being much more rarefy'd and expanded at one time

than at another: and therefore as the arterial Blood being hotter, is longer in effecting this Separation than the Venal; so in a high inflammatory Fever, the venal Blood requires a considerable time of standing in a cool place, before it can throw off its Serum: but in a cold condensative State and Disposition of the Blood, this Separation or Solution is procured almost presently; for 'tis plain that the more the Globules are heated, expanded, and enlarg'd, the nearer they will come in specifick Gravity to the Serum, and consequently retain any given Position in it: besides, the greater the expansive Force is which has been impress'd upon these Globules, the more the corpuscular Attraction of their Parts must be resisted and retarded, which must resist and retard their Union, Cohesion, and Subsidence.

From this difference therefore in the Separation or Solution of the Serum and *Crassamentum*, the different Proportions of the expansive and attractive Forces, and consequently the different State and Degrees of the natural Heat, in Fevers and other Diseases, may be rationally determin'd and judg'd of: and this shews of what consequence it is to a Physician, in most Cases, to take at first a little Blood, that he may be enabled to judge of its State and Constitution, whether there be any other occasion for Bleeding or not; for as this can do no harm, so it may often be of great use.

THERE is, however, another partial Cauſe of this different Solubility in the Blood, beſides the different Degrees of its Heat, and Rarefaction, and that is the different Proportion of the Serum to the *Craſſamentum:* for where the Serum bears but a very ſmall proportion, it will cohere the more ſtrongly with the *Craſſamentum*, and be ſeparated with the greater difficulty. Beſides, where there is but a ſmall quantity of Serum, it will be ſtrongly tinged with the Oils and Salts of the *Craſſamentum*, which will render it nearly of the ſame ſpecifick Gravity, and conſequently retard or hinder its Separation. But indeed, where there is this abounding of the *Craſſamentum* in the Blood, there is for the moſt part a proportionally abounding Heat; and therefore this Caſe is almoſt coincident with the former, tho not perfectly the ſame.

7. THE Conſideration of the different Directions, or determinate Motion of the circulating Blood, is a matter of great conſequence: for tho the Blood continually circulates, and is diſpens'd from the Heart thorow the Arterys to all the Parts, yet a Man would be very much miſtaken, who ſhould imagine that all the Parts and Organs to which the Blood is diſpens'd continually, receive their due proportion and ſhare, and that this Circulation is always equable and uniform. All Phyſicians know to what great Irregularitys the Blood is liable in its different Direction and Determination; and enough has been ſaid already of that great, general, and moſt

remarkable difference in Motion and Direction of the Blood, with reſpect to its occaſional and various afflux or reflux to and from the Head. Any conſiderable *Stimulus* will derive the Blood in larger Quantitys to the ſtimulated part, which muſt break and interrupt the *Æquilibrium* and Uniformity of its Circulation: and from hence it comes about, that a great part of a true and regular Practice, conſiſts in deriving, revulſing, and variouſly directing and determining the Blood, in order to recover its *Æquilibrium* and due Circulation.

THESE are the ſeveral Appearances and Phænomena which chiefly come under the Conſideration of a Phyſician, with regard to the various and different State, Conſtitution, Texture, and Diſpoſition of the Blood; and as theſe are all ſenſible Qualitys, their Effects muſt be accordingly great and ſenſible.

FROM the ſeveral prevailing Compoſitions, or Combinations of theſe Qualifications and different Diſpoſitions of the vital Fluid, various compound Conſtitutions will ariſe, requiring a different Method and Procedure: thus for inſtance, either a hot and rarefy'd, or a cool condens'd ſtate of the Blood may be attended with great Viſcidity and Tenacity of the Parts, or on the contrary with an immoderate Fluxility and Tenuity; in which the natural coheſive or balſamick Quality of the Blood may be leſſen'd, and in a great meaſure loſt. And from hence there will ariſe four dif-

different Conſtitutions, the obſervation and right underſtanding of which, will be of great conſequence; namely, a rarefy'd Viſcidity, and a rarefy'd Fluxility; a denſe Viſcidity, and a denſe Fluxility. The farther Conſideration of which, and their different Conſequences, will fall under ſome of the following Propoſitions.

PROPOSITION II.

TO cool, dilute, and attenuate the Blood.

THE too great Heat and Viſcidity of the Blood, is one of its moſt generally prevailing morbifick Conſtitutions; eſpecially in ſuch a Country as ours, abounding with all the Temptations to, and Proviſions for Eaſe and Luxury: for this morbid ſtate of the Blood is certainly brought on for the moſt part by drinking too freely of hot, ſpirituous, inflammable Liquors, and feeding plentifully on things which contain a large Proportion of volatile oily Salts; ſuch as Fleſh Meats half boil'd or roaſted, eaten in their red bloody Gravy, and all hot, ſpicy, and high-ſeaſon'd Broths, Sauces, or other Foods.

THE Blood being thus over-heated and rarefy'd, the Serum is in conſequence thicken'd, coagulated, and turned into a ſort of Gelly; by which means it muſt be render'd unfit for Motion, cohere too ſtrongly with the *Craſſamentum*, and paſs but ſlowly thro the Lymphaticks and glandular Strainers.

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In this State and Disposition of the Blood, the thicker and more viscid Parts of the Serum must needs lodge upon the Lymphaticks and common Receptacles of the Glands, till they are gradually fill'd up, obstructed, tumefy'd, and preternaturally distended. From which gradual Obstruction of the Glands, and diminish'd or intercepted Circulation of the animal Fluids, the Heat and Viscidity of the Blood still increase, till the vital Flame raised too high, is suddenly extinguish'd in the cold Embraces of Death.

This morbid state of the Blood, and all its evil Symptoms, are exceedingly heighten'd and aggravated by a sedentary Life, or the want of sufficient Motion and Exercise. For while the natural Action of the muscular *Fibrillæ*, is either not at all or but little assisted and promoted by voluntary Motion, the Glands and their common Receptacles must be the sooner stuff'd up and obstructed; and the Circulation of the Lymph, that great and powerful means by which Nature continually cools and dilutes the Blood, will in a short time be suspended. By this interrupted Circulation of the Lymph, the natural Heat being rais'd too high, a Fever will ensue; which after such a general and obstinate Obstruction of the Lymphaticks must prove incurable.

From this account of the Causes, 'tis evident that Temperance and Exercise must be necessary and essential to the Cure. No Medicines

dicines can be of much uſe where a Man will not govern his Appetites by Reaſon, and employ the Powers and Inſtruments which God has given him for Exerciſe and voluntary Motion.

Among all Liquors, Water is beyond controverſy the moſt excellent and effectual to cool and dilute the Blood, to waſh off the Viſciditys and obſtructing Coheſions of the Glands, and to keep the animal Fluids in a due ſtate of Fluxility and Motion: and therefore this had doubtleſs been ſtill retain'd as the common Drink of Mankind, had not the abuſe of Reaſon in artificial Intemperance prevail'd ſo far, as to ſet aſide one of the main Principles and greateſt Preſervatives of Health.

The proper time for cooling and diluting the Blood, is in the Morning or before Dinner: for ſince all the expurgatory Secretions, and particularly the ſalival and urinary Diſcharges, are leſſen'd during a ſtate of Sleep; thoſe Glands, by reaſon of the ſlower Motion of their ſecreted Liquors, contract a Foulneſs from certain Portions of a thick, viſcid, or ſlimy Serum, left behind, and ſticking or adhering to them. Now to waſh off theſe viſcid Recrements collected during the time of Sleep, diluting in the Morning is of the greateſt conſequence, and what ought not to be diſpens'd with by thoſe who have a juſt Concern for their Health. To which purpoſe, a large Glaſs or two of good ſoft Water from

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marly or chalky Springs, drank first in the Morning, a Breakfast upon Water-Gruel, Milk-Porridge, Green Tea, or some such-like cooling diluting Method is exceedingly beneficial. If any thing stronger be taken in the Morning, the best Season for it is a little before Dinner, at which time a Glass of White-Wine, or even a Draught of fine thin Ale, where a Faintness or too great Depression calls for it, may be allow'd; but otherwise it is much better omitted. And for such as instead of this cooling diluting Method, begin in the Morning upon Drams and strong Liquors, and indulge themselves in this Practice till they have made it in a manner necessary to raise and keep up their Strength and Spirits; when Matters are brought to this pass, the best Advice that can be given a Man, is, to settle his Affairs, since his Days may be easily numbered, and his time in this World cannot be long.

WHAT has been here said, is chiefly to be understood by way of Prevention, in those who have hitherto retain'd a tolerable state of Health. But where this morbid State has been long fix'd, and deeply radicated, till the Lymphaticks and glandular Receſſes are strongly and obstinately obstructed by hard compact Concretions of the Serum, mix'd with the Salts and fabulous Recrements of the Blood; in this case, I say, all the cooling and diluting in the World, by any of the common Methods, will not be sufficient. Here therefore some

ſome powerful effectual Deobſtruents muſt be made uſe of, ſuch as may be ſufficient to diſſolve, attenuate, and carry off the viſcid indurated Concretions in the Glands. And to ſpeak impartially, I know but one thing in the World that is capable of doing this with any great certainty or ſucceſs, and that is *Mercury*: the milder Preparation of which, given in moderate Doſes, and long continued, ſo as not ſenſibly to affect the Stomach and firſt Paſſages, nor procure any conſiderable ſenſible Evacuation, will do wonders in all glandular Caſes, and ſuch as would be altogether incredible, were not the Effects ſufficiently confirmed by Experience.

I KNOW it is an Opinion pretty much prevailing, that very weak People, eſpecially the Hypochondriacal and Hyſterical, cannot bear the uſe of Mercury; and that this Mineral being inimical to the Nerves, ought not to be given in nervous Caſes: but it is not yet well agreed, what Diſeaſes are or are not truly and properly nervous. Almoſt all Diſeaſes have been attributed to the irregular Motion of the animal Spirits; and all Diſeaſes proceeding from the Spirits muſt, I ſuppoſe, be nervous. In the mean while, beſides what has been ſaid *Prop.* 13. *Part* II. it might be eaſily demonſtrated farther, by other numerous Obſervations and Experiments, were it neceſſary, that moſt of thoſe Diſeaſes which have been peculiarly call'd Nervous, are owing to certain Obſtructions, Tumors, and Ero-

Eroſions of the glandular Organs or Bowels contain'd in the Thorax and Abdomen; and that the Matter of theſe Obſtructions is often of ſuch a nature, that nothing but Mercury can diſſolve, attenuate, and diſcuſs it. Every body knows the egregious Power of Mercury, in diſſolving and diſcuſſing the Tumors, Concretions, and Indurations of the Glands, both in its outward Application and inward Uſe: And if we muſt not make uſe of the moſt effectual Deobſtruent to remove the moſt obſtinate Obſtructions, I think we might juſt to as good purpoſe do nothing at all.

As to what is alledg'd, that Mercury is hurtful to the Nerves, I am clearly and experimentally perſuaded, that this Enmity to the Nerves proceeds not from the bare Uſe, but from the Abuſe and injudicious Management of it. For my own part, I have conſtantly uſed it in ſuch a manner as to do no injury at leaſt, and for the moſt part with good ſucceſs in ſuch chronick Caſes as are commonly reckon'd moſt peculiarly nervous. And therefore I look upon this Objection of Mercury being injurious to the Nerves, to be of no conſequence at all, unleſs it ſhould be thought that the Miſchief enſuing from the Abuſe of a thing, can be a good Argument againſt the right and beneficial Uſe of it: and indeed there are ſome mere Quacks, otherwiſe Men of no conſequence at all, who yet from their Performances by Mercury in a ſlow, gradual way of giving it, ſo as not to injure

injure the Stomach and firſt Paſſages, are a ſhame to Learning and regular Practice.

THE Reaſon of this Effect of Mercury, as the greateſt and moſt powerful Deobſtruent, or the manner of its Operation as ſuch, is very evident from its ſenſible and moſt obvious Qualitys; namely, its Weight, Fluxility, and minute Diſcerpibility of its Parts, or Aptneſs to rarefy, diffuſe, and expand it ſelf upon a ſmall degree of Heat. And ſuch is the extreme Diſcerpibility, or Minuteneſs of Parts into which this ſurprizing mineral Fluid is capable of being divided, that notwithſtanding its great Weight and Denſity, which is to Water as 14 to 1, yet by a ſmall degree of Heat, it becomes as volatile and expanſive as the fineſt Spirit or moſt volatile Salt. From theſe Propertys, when Mercury is convey'd into the Blood and mix'd with the circulating Maſs, it will, according to the different manner of giving it, and the different State and Diſpoſition of the animal Machine, be attended with the following Conſequences.

1. WHEN it is exhibited ſlowly, and in ſmall Quantitys, being minutely divided, rarefy'd, and equally diffuſed thro the whole Maſs, it muſt paſs off uniformly and proportionally with all the Secretions, ſo far as theſe Secretions are equally free and open, or where the Reſiſtance is every where equal: and in this Caſe the Effect of the Mercury will be only by its greater motive Force to

increaſe the Velocity and Moment of the Blood, and thereby to augment all the Secretions in the ſame Proportion. But when the Reſiſtance is unequal, the greateſt Quantitys muſt paſs in a given Time thro thoſe Pipes or Canals where the Reſiſtance is leaſt; which is a Property in common to this with all other Fluids.

2. When Mercury is given in large Doſes, or frequently repeated, ſo as to throw a conſiderable Quantity of it into the Blood in a ſhort time, it will not be capable in this Caſe of rarefying and diffuſing it ſelf gradually and uniformly, as where it is given ſlowly and in ſmall Quantitys: but its ſudden Rarefaction and extreme Volatility acquir'd by the natural Heat, muſt determine its principal Force and Efficacy upward; that is, it muſt riſe in a ſtrong plentiful Steam or Vapour to the Head, and be thrown off by the ſalival Glands: and this not only as theſe Glands are ſituated in the ſuperior Part of the Body, to which the Mercury by a ſudden Rarefaction, and before it can have time to diffuſe it ſelf, muſt neceſſarily riſe; but likewiſe as theſe Glands are more free and open than moſt others, and continually diſcharging an eaſy Flow of the Saliva.

3. When Mercury is convey'd or carry'd into the Blood ſlowly and gradually, ſo as to give it time to diffuſe it ſelf pretty equably and uniformly, tho the greateſt Quantitys in a given time will paſs thro thoſe Glands which are moſt

moſt free and open, or where the Reſiſtance is leaſt; yet its principal and moſt ſenſible Effects will be upon ſuch Glands as are moſt obſtructed, or where the Reſiſtance is greateſt. For let us ſuppoſe any particular Gland to be obſtructed with a thick, viſcid, and ſtrongly cohering Matter, ſo that the Blood and Lymph in their natural Courſe of Circulation cannot paſs; and let us ſuppoſe at the ſame time this circulating Blood and Lymph to be repleniſh'd and diffus'd with a certain Quantity and Proportion of Mercury: then 'tis plain, that the Mercury contain'd in and diffus'd thro the Blood and Lymph, being indu'd with a greater *Momentum Motus*, and a ſtronger corpuſcular Attraction, by reaſon of the Smallneſs and Denſity of its Parts, will paſs where the Blood and Lymph cannot: and conſequently the Mercury, by its greater moving Force and ſtronger corpuſcular Attraction, will penetrate into the viſcid cohering Matter of the obſtructed Glands, and be retain'd in it till it is accumulated in ſuch a Quantity and Proportion as to be capable of diſſolving the viſcid, cohering, obſtructing Matter, and puſhing or driving it forwards into the larger and more open Veſſels.

THO a greater Quantity of Mercury therefore in a given Time will paſs thro the open and unobſtructed Glands, yet in a longer time a greater Quantity will be retain'd and accumulated in the obſtructed Glands, till the great Quantity of the retain'd Mercury,

partly by its rarefying expansive Force destroying the corpuscular Attraction and dissolving the viscid Cohesion, and partly by its greater projectile Force, cleanses and throws out the obstructing Matter from the Glands and small Vessels into the large and more open Canals, where it is disposed and prepar'd to be carry'd off thro the several Emunctorys by the natural Evacuations.

4. When a Substance of such Force and Efficacy as Mercury, is thrown suddenly, in great quantitys, and with violence, upon any of the Glands, it must needs be extremely hurtful and mischievous: for in this Case the sudden Rarefaction, expansive Force, and violent Efforts of the Mercury, rous'd and excited into Action by the natural Heat, must over-stretch the nervous motive *Fibrillæ*, suspend their Action, and quite break, dissolve, and destroy the natural Structure and Conformation of the Parts; and the Structure and Organization of the Solids being thus broken and destroy'd, the Fluids must stagnate, corrupt, and putrefy in the Organs, and the Obstructions become inveterate and incurable.

Hence it is that they who have been too severely treated with Mercury in the *Lues Venerea*, are very often made more deplorable Victims to the Fury of the Medicine than to that of the Disease; and a Distemper which scarce deserves a Cure, is render'd uncapable of any. I know that the unhappy in this

Case are generally impatient of Delay, and eager for a speedy Cure; but the Event seldom answers their Expectations, and a little present hasty Relief is for the most part follow'd with a long train of hopeless and remediless Evils, which might have been prevented by a more rational and deliberate Method.

5. The mildest Preparations of Mercury, and such as will not salivate at all, as Æthiops Mineral, Cinnabar, or the like, when given too fast, or in too great Quantitys, are often attended with very bad Consequences, as Loss of Appetite, violent Cholicks, Diarrhæas, Erosions of the Stomach, Intestines, &c. and all these ill Consequences are still more dangerous from its stronger Preparations, when given after the same manner; for by this means all the salutary beneficial Effects of the Mercury upon the remote Glands are eluded and prevented, while an otherwise most excellent Medicine is converted into a Poison. And tho Cures may be sometimes wrought by great violence in strong Constitutions, yet whoever considers the prodigious Force of this Medicine, will, I am perswaded, think it most reasonable to go gently to work with it, and give it more time.

6. It often happens, that too large Quantitys of the Lymph or Serum being long retain'd in the Lymphaticks and common Receptacles of the Glands, the Organs by such an over-stretch and tensity lose their Elasticity and restitutive Force, and consequently

become loose, and flabby; from whence the Communication of such stagnating Lymph with the other circulating Lymph being suspended and cut off, the Organ will be obstructed. Under such a Circumstance, the retain'd stagnating Lymph will in the first place by Rarefaction and Fermentation throw off its most volatile, soft, and balsamick oily Salt; and retaining only its ponderous resinous Oil and fix'd Salt, it must hereby become sharp, acrimonious, and corrosive: and this sharp, corrosive, and extremely penetrating Serum, by vellicating the nervous Coats of the Vessels, eroding and eating off the Ligaments and Bandages of the Joints and Tendons, and piercing thro, and soaking, corrupting and mortifying the very Bones, must induce the worst Degrees and Symptoms of the Scurvy, and produce various Phænomena or Appearances, according to the principal Parts and Organs chiefly affected, as explain'd and exemplify'd *Prop.* 13. *Part* II. Now in this case Mercury is the great Specifick, Sweetner, and powerful Corrector of any such sharp, corrosive Acidity: for by opening the obstructed Canals, and procuring a Communication with the circulating natural Lymph, that which had before contracted a corrosive Acrimony, by stagnating and fermenting in the Glands, will be again repleniſh'd and saturated with the soft balsamick Oil of the natural Lymph. And from hence it is that Mercury is so effectual

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in taking off, or qualifying the Acidity's of the Glands, and correcting the Malignity of all sorts of foul, eroding, and fistulating Ulcers.

7. FROM this account of Mercury, 'tis evident that its great and principal Efficacy consists in dissolving, attenuating, and cleansing off any viscid Concretions of Matter which may have been lodg'd upon the Glands, or their several Strainers, conveying Pipes, and common Receptacles. But the Matter thus clear'd and thrown off from the minute obstructed *Tubuli* and glandular Recesses, may not afterwards be sufficiently discharged and cast out by the natural Evacuations. Now in this case the Stomach is for the most part the first and greatest Sufferer: for any corrupt vitiated Serum, which had been stagnating, concreting, and putrefying in the Glands, being dissolv'd and attenuated by the Mercury, and thrown out into the larger and more open Vessels; if Nature does not find out a quick and speedy Discharge for it by some of the regular Evacuations, it will be soon thrown upon the Stomach, and affect that Organ with such an Irritation, *Stimulus*, and Loathing, as to give the Physician a plain and natural Indication for the usefulness and necessity of Vomiting: by which means the corrupt, stagnating, obstructing Matter, having been attenuated, dissolv'd, and thrown out of the Glands into the larger Vessels, may now be most safely and effectually drawn off, and

caſt out of the Body. And I may venture to pronounce, that in all the Species and Appearances of the Scurvy, as explain'd *Prop.* 13. *Part* II. this Method will be ever found moſt ſafe and ſucceſsful.

In any Courſe of Mercurials, Diureticks likewiſe are of great ſervice. 'Tis well known to the Phyſicians, that there are many Diſeaſes, the corrupt *Stamina* and glandular Lodgments of which are beſt and moſt effectually carry'd off by the urinary Diſcharges. And indeed where this Secretion ſucceeds right, there is ſeldom need of any other: for by this means the Stomach being kept clear and free, there will be no great neceſſity for Vomiting, which otherwiſe ought not to be diſpens'd with, unleſs ſome peculiar Symptoms or Appearances forbid it.

8. The various Effects of Mercury, and its ſeveral curative Intentions, are very much promoted, and differently determin'd by the four following Simples; namely, *Guaiacum*, Roots of wild Valerian, black Hellebore, and Rhubarb: of which it may be obſerv'd, that the two former, that is, the *Guaiacum* and wild Valerian, have a peculiar Efficacy in throwing the Matter of any glandular Diſeaſe outward, and terminating it upon the cutaneous Glands; where it is much better manag'd than when it falls inwards upon the Stomach, Inteſtines, and glandular Organs of the Abdomen. On the other hand, the black Hellebore and Rhubarb have a particular

ticular Efficacy in precipitating the Matter of any glandular Diſeaſe downward, and carrying it off thro the urinary Diſcharges. But this may be eſpecially remark'd concerning the black Hellebore, that where it is mix'd or compounded with the Gum *Guaiacum*, wild Valerian, or any thing elſe of a like warm and effluent nature, it ſerves to promote Perſpiration, or a Diſcharge thro the cutaneous Glands, more than any thing elſe that I have ever met with. I have menti-on'd the *Guaiacum* and wild Valerian to the Purpoſe aforeſaid; tho indeed the *Serpentaria Virginiana* and Saffron, are more quick and powerful to the ſame Intention; that is, their Effects are the more ſenſible, and are therefore in ſome Caſes preferable to the other, as will afterwards appear. But the *Guaiacum* and wild Valerian have in this Caſe ſomething *ſpecifick*, if I may ſo ſpeak; or, which is the ſame thing, and all that I mean by it, they have a peculiar Efficacy in diſſolving, attenuating, and throwing outwardly the Matter of glandular Diſeaſes.

If any one ſhould demand the Reaſon of this, I muſt own that I know nothing of it but from Experience, which plainly evinces the Matter to be ſo in Fact; and this is perhaps the only Reaſon that can be given for the peculiar characteriſtick Effects of the Bark, Opium, or any other medicinal Simple.

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SCHOLIUM I.

I DESIRE it may be here obſerv'd, that what I have ſaid of Mercury as one of the moſt effectual and powerful Deobſtruents, is to be underſtood as abſtracted from Salivation, or any ſuch way of giving it, as to promote any great, ſenſible, or violent Evacuation. For where Mercury is thus given, it muſt needs break, diſſolve, and deſtroy the natural Texture and Conſtitution of the Solids and glandular Organs, upon which it happens to be precipitated and thrown with ſuch Violence: and the elaſtick motive *Fibrillæ* having thus loſt their natural Force and proper Action, any Lodgment of viſcid obſtructing Matter upon ſuch Glands for the future, muſt be fix'd there without Remedy, and the Obſtruction become incurable. And hence it is, that they who have been injudiciouſly treated with Mercury, by too ſtrong and violent Salivations, are often reduced to the moſt deplorable Circumſtances, and put out of all the Hopes and Poſſibility of a Cure by any other Method.

I KNOW it will be urg'd by ſome, that Salivation in a high degree is neceſſary to the Cure of the Venereal Diſeaſe, where it is once ſtrongly or deeply fix'd. But ſuch is my Incredulity and Diffidence, that I am very apt to queſtion the Truth of this in Fact; and I only deſire thoſe who have any great Experience in this Caſe, to tell us faithfully whe-

whether they have ever known a good Cure wrought by a high Salivation upon such as have been much afflicted with hypocondriacal or hysterical Disorders; and whether the Success has not fail'd in proportion to the strength of the Salivation, and the Overstretch of the obstructed convulsed Glands? But this I think is certain, that the greater the Obstruction of the Glands is, and the more they are tumefy'd, distended and stimulated, the less capable will they be of any violently impress'd Force of Mercury, and the more necessary will it be to do the Work with more Moderation and in longer Time.

SCHOLIUM II.

SINCE Mercury is the greatest and most powerful Deobstruent, by this Proposition; and since Fevers arise from an Obstruction of the Lymphaticks and chyliferous Ducts, by *Prop.* 14. *Part* II. it may perhaps be here demanded, How it comes about that Mercury is not the most effectual Remedy in Fevers, where however it is not trusted, and has never been observ'd to have any considerable good Effects? In answer to which, it may be observ'd, that Mercury as a Deobstruent has its principal Effect upon the most fix'd, obstinate, and concreted Obstructions of the Glands, and such as require some considerable Time for their Attenuation, Dissolution, and Discussion. And therefore in all chronick glandular

Diſeaſes, in which the Heat and Viſcidity of the Blood come not up to a direct and proper Fever, Mercury, under the Limitations and Reſtrictions already mention'd, is the only certain effectual Deobſtruent that I know of in the World: but in Fevers, eſpecially ſuch as are acute, the nature of the Obſtruction is very different, and requires ſuch a deobſtruent Method as may be capable of diluting the Fluids, ſtimulating the Solids, and recovering the Circulation of the obſtructed Lymph in a ſhort time; without any ſuch Violence as muſt be the neceſſary Conſequence of giving Mercury in large Quantitys, ſo as to produce any great and ſudden Effects. When the lymphatick Drain is ſuſpended in an acute Fever, ſomething or other muſt be quickly done to reſtore the obſtructed Circulation, or elſe the only time will be loſt in which the Patient is capable of being reliev'd. Mercury therefore in this Caſe is not a proper Deobſtruent, becauſe it cannot be given faſt enough and in ſufficient Quantitys, without great Danger. Nothing, 'tis plain, could be of worſe conſequence in Fevers, than throwing the Blood and Humors ſuddenly and with violence upon the Head, which yet muſt be the Reſult of giving Mercury in large Doſes; and if it ſhould be given but ſlowly and gradually, the Fever would deſtroy the Patient before the Deobſtruent could have its Effect.

In this Caſe therefore, there is need of ſome other Deobſtruent or glandular Cathartick, which by its attenuating and ſtimulating Propertys may be capable of cleanſing the Glands, and recovering the Circulation of the Lymph in a ſhort time, and without any ill Conſequence. And ſuch a lymphatick Deobſtruent, or glandular Cathartick in Fevers, is Cantharides, as apply'd in Epiſpaſticks: After what manner they operate, and how wonderfully they cool and dilute the Blood, by procuring a ſpeedy and ſafe Circulation of the obſtructed Lymph, has been ſufficiently explain'd already at *Prop.* 14. and 15. *Part* II.

PROPOSITION III.

TO retain the Æquilibrium *of the circulating Blood, againſt the frequent occaſional Affluxes and Refluxes of the vital Fluid.*

From what particular Occaſions, and by what ſort of Mechaniſm this *Æquilibrium* of the Blood may be broken or interrupted, I have largely enough conſider'd and explain'd in ſeveral of the foregoing Propoſitions. It remains here therefore only to conſider the medical Operation, how this different Direction and Determination of the refluent Blood, may be turned one way or the other as occaſion ſerves, in order to recover and retain the *Æquilibrium.*

THE general Intention of raising and diffusing the vital Fluid, as abstracted from all other Symptoms, is best obtain'd by the *Serpentaria Virginiana*, and Saffron. Opium has likewise a very great Force and Efficacy this way: but in all great and obstinate Obstructions of any of the principal Organs, Opiates are to be sparingly and cautiously used, with the Regulations and Restrictions already laid down, *Prop.* 17, 18. *Part* II.

THE contrary Intention of depressing and repelling the Blood, (when it happens to be raised and diffused with a too great Force and Impetus) may be easily obtain'd from the *Testacea*, Sal Prunel, Rhubarb, and all cooling diluting Liquors. Bleeding also and Glisters are very efficacious to the same Intention; but the former ought to be directed with greater Nicety and Care than is commonly imagin'd. Acids likewise of all sorts; as Juice of Lemons, Spirit of Sulphur, *&c.* in Juleps and Draughts, serve very well to cool, condense, and repel the over-heated effluent Blood.

BUT I cannot here forbear mentioning and doing Justice to one thing, which perhaps may be despis'd because it is too common; I mean Apples, especially the gratefully acid and oily sort, such as the Kentish Pippin, Pearmain, Pomeroy, Nonparelle, *&c.* these are moderately cooling, diluting, attenuating, cleansing, and balsamick; they condense and precipitate the Matter of a too hot and flatulent

lent Digeſtion, cool and refreſh the Stomach and Bowels, attenuate and propel the *Fæces*, and promote a moſt natural and benign Evacuation by Stool. In ſhort, under all hot, flatulent and rarefactive Diſorders of the Chyle, Lymph, and Blood, they are an excellent Stomachick, Pectoral, and Diuretick.

When the Blood in this interrupted *Æquilibrium* is various and differently determin'd, ſometimes one way and ſometimes the other, the Simples under each Intention muſt be accordingly mix'd and variouſly compounded; of which the Phyſician will be only capable of judging by a careful Conſideration of the Symptoms and preſent Appearances.

PROPOSITION IV.

TO recover and maintain an equal or due Proportion of the Craſſamentum *and Serum in the Blood.*

Tis manifeſt, that either the one or the other of theſe, the *Craſſamentum* or the Serum, may abound in a too great Quantity and Proportion with reſpect to the other; or which is the ſame thing, the *Craſſamentum* may bear a too large or a too ſmall Proportion to the Serum.

By indulging the too free and plentiful uſe of ſuch Meats and Drinks as abound with rich Oils, Sulphurs, and volatile Salts, the quantity of the *Craſſamentum* is immoderately

ly augmented; and this occaſions a hot flatulent Digeſtion, and diſpoſes to all ſuch Diſeaſes as proceed from Heat, *Flatus*, and Rarefaction: and what theſe are, and with what different Symptoms and Appearances attended, has been conſider'd already.

HERE therefore, the beſt Method of Cure is to take away the Cauſe; that is, to live ſoberly and temperately, to feed ſparingly on Fleſh well boil'd or roaſted, with plenty of Garden-ſtuff; to forbear all Exceſs in hot, ſpirituous, fermented Liquors; and to uſe a cooling diluting Method, by drinking Water, Green Tea, eating Water-Gruel, Milk-Porridge, Milk and Apples, *&c.* eſpecially in the Morning: for this may be taken as a certain Rule, that the Morning is the proper Seaſon for diluting, and the Evening for chearing, invigorating, and raiſing the animal Conſtitution, if need be, after the Labour and Fatigues of the Day.

THERE is another Method of leſſening the *Craſſamentum*, where it too much abounds in quantity with reſpect to the Serum; and that is by frequently repeated Bleeding in ſmall or moderate Quantitys. For the *Craſſamentum* being a ſtanding Quantity like the Fleſh or Fat, tho this part in Bleeding is drawn off proportionally with the Serum, yet it will not be recovered, or increaſed afterwards in the ſame time; and therefore by frequent Bleeding the Quantity of the *Craſſamentum* will be diminiſh'd, and that of

the

the Serum proportionally increaſed. But this neceſſary Caution muſt be obſerved with reſpect to Bleeding, as the means of leſſening the *Craſſamentum*, that ſuch an Intention cannot poſſibly be obtain'd by it, where the Lymphaticks are torn and dilacerated in a Dropſy, ſo as to let out their Serum into the Cavitys of the Body. In this Caſe, while the Serum is continually running off thro the broken Lymphaticks, the *Craſſamentum* muſt needs abound in the Blood-Veſſels, there being little elſe left: But here tho the Proportion of *Craſſamentum* to the Serum is too great, yet the abſolute Quantity of the Blood is exceedingly diminiſh'd, by the continual Drain of Lymph into the Cavitys of the Breaſt and Abdomen. And therefore 'tis plain that Bleeding in this Caſe can be of no ſervice, but on the contrary muſt be extremely hurtful and miſchievous.

WHAT has been here ſaid of a Dropſy, may be equally underſtood of any immoderate Evacuation, in which the Serum being thrown off too faſt, the proportion of the *Craſſamentum* will be too great while the Quantity of Blood is diminiſh'd: in all which Caſes Bleeding muſt be very prejudicial, and the only true Method of Cure will conſiſt in ſtopping or reſtraining the preternatural Evacuations.

BY a too cold and ſlow, or a too quick, precipitated, and ſcorbutick Digeſtion, the

Proportion of the *Craſſamentum* to the Serum will be preternaturally diminiſh'd, while the Blood in its abſolute Quantity continues the ſame. In this caſe, to reſtore the natural Proportion of theſe two Principles in the Blood, the Error of Concoction muſt be corrected, which ariſes either from a Defect of the natural digeſtive Heat, or from a ſcorbutick Taint fix'd upon the Stomach, or from both theſe variouſly mix'd and join'd together: in both which the Method of Cure may be eaſily collected from *Prop.* 16. *Part* II. concerning Digeſtion.

PROPOSITION V.

TO ſtrengthen and keep up the elaſtick Tone, or muſcular Force of the Nerves.

THE nervous elaſtick *Fibrillæ* are ſubject to two contrary Indiſpoſitions, or morbifick Conſtitutions: for either they may be ſtiffen'd, harden'd, and contracted, ſo as not to be capable of ſtretching by any ordinary Force or ſtretching Power; or, on the other hand, theſe motive elaſtick Fibres may be ſtretch'd and relax'd beyond their natural Tone, or Capacity of Reſtitution and Contraction.

Now 'tis well known, that any elaſtick Thread or Fibre, by being over-dry'd, whether by Heat or Cold, will become ſtiff, hard,

hard, and inflexible; upon which it will immoderately contract, ſo as to loſe its capacity of being ſtretch'd and diſtended. But on the contrary, any ſuch elaſtick String being over-ſoak'd and drench'd in Water or other ſuch-like Fluid, will become ſoft, lax, and flabby; and in this Caſe it may be eaſily ſtretch'd, or drawn out by a ſmall Force, but will be uncapable of recovering, or contracting it ſelf again, when that ſtretching Force is taken off.

THIS is plainly matter of Fact and Experience; and from hence it muſt follow, that theſe two contrary States, or morbifick Diſpoſitions of the Nerves, are owing reſpectively to the too great Drineſs, and Moiſture of the Conſtitution: And from this Conſideration, the true and natural Indications of Cure, either in the one or the other, may be eaſily underſtood and apply'd in Practice. The ſoft, lax, and flabby State and Conſtitution of the Nerves, is brought on by all the Methods of Luxury, Exceſs, and indulged Reſt or Inaction; from whence the Fluids contract a Viſcidity, and are immoderately accumulated, and heap'd up upon the over-ſtretch'd, diſtended, and obſtructed Glands; by which is induced a weak, feeble, and enervated Conſtitution. This is likewiſe the natural State and Diſpoſition of Children, in whom the Fluids bear a great Proportion to the Solids; and Women are,

cæteris paribus, more liable to it than Men. The contrary ſtate of Stiffneſs, Rigidity, and Inflexibility of the Nerves and motive *Fibrillæ*, is brought on by exceſſive Exerciſe and great Fatigues, immoderate Watching, too great Evacuations; and by all the drying emaciating Paſſions, as Anger, Revenge, Envy, Malice, Madneſs, and exceſſive Deſire in every thing.

THIS is likewiſe the natural Diſeaſe of old Age; in which the motive *Fibrillæ* and Coats of the Blood-Veſſels, gradually contract a Stiffneſs, Rigidity and Drineſs; the Cartilages indurate, and grow as hard as Bones; and the ſofter Coats, Ligaments, and Membranes become Cartilaginous.

IT may be here obſerv'd, that Water, which is the common Vehicle of all our Food and Nouriſhment, is more or leſs ſtock'd with Sand, Gravel, Chalk, and other ſtony and fabulous Matter, which being convey'd into the Blood, and there attracted and retain'd by the Solids, they are in long run exceeding apt to petrify; and when this Petrification happens upon any of the principal Organs, eſpecially upon the Valves of any of the great Blood-Veſſels, it neceſſarily deſtroys their natural Uſe and organick Action, and renders any ſuch Diſeaſe abſolutely incurable. It is therefore perhaps happy for thoſe who before they are thus affected, are in good time bleſs'd with the Gout; by

which

which that fabulous Matter which is retain'd in the Blood, not passing off as it ought thro the urinary Drains, is derived plentifully to the extreme Parts of the Body, and the more necessary or vital Organs hereby guarded and secur'd. From what has been here observed of the Causes, the curative Intentions, or the Method of securing the Nerves against these two opposite Evils, will be easily understood by such as have a Genius for this Study; and they who have not, would not be much the better for a larger Explication.

PROPOSITION VI.

TO promote and keep up the natural Evacuation or Secretion by Urine.

From what has been said *Prop.* 13. *Part* II. it is evident that this Intention is of the utmost Importance to Health and long Life; that most chronick Diseases are owing to the want of a due and regular Secretion by Urine; and consequently that a numerous Train of severe Evils may be prevented by a just Regard to this necessary Discharge. Now the obtaining this Intention, will depend upon considering duly the different State and Circumstances of the general Case. For,

1. As

1. As to those who have indulg'd a Method of hot Intemperance, till they have over-rais'd and heated the Blood, and contracted a flatulent Digestion; the most effectual Diureticks to them will be Water, Green Tea, Apples, Milk and Apples, or a thin Emulsion made of the Pulp of roasted Apples, with any cooling diluting Liquor; especially if such a Method be constantly taken in the Morning, which will be the most effectual way to throw off and discharge any such viscid Lodgments upon the urinary Glands, as had been contracted and accumulated during the time of Sleep.

2. In cold, low, and languid Constitutions, where the Secretion is lessen'd from a diminish'd Velocity of the Blood, Infusions of Horse-Radish, Mustard and Gromwell-Seeds, Millepedes, a few Drops of the Balsam of *Capivi*, and such warm stimulating Diureticks mix'd with Diluters, will be most effectual.

3. When the urinary Glands are very much stuff'd and loaded with Gravel, or any fabulous Matter which cannot be thrown off by the common Diureticks, recourse must be had to Cantharides; which given in small Quantitys, not exceeding five Grains, and well diluted with any thin, soft, and milky Liquor, is beyond all dispute the most powerful and effectual Diuretick in the World.

4. When

4. WHEN the urinary Glands and Paſſages are ſcorbutically affected, dilacerated and eroded, the curative Intention cannot be obtain'd without Mercurials; the Nature and Uſe of which has been already explain'd.

5. BUT the greateſt difficulty of obtaining this Intention is in Dropſys; where the great and general Stretch or Diſtenſion of the Lymphaticks and Glands throout the whole Body often eludes the Force of all poſſible Diureticks. In this Caſe the beſt and moſt effectual Method of drawing off the Waters, is by Bliſtering; keeping ſome one or more of them continually running in ſeveral Parts of the Body, till the Water is diſcharg'd, which by this means will be effected in a ſhort time to a wonder: and then any of the common Diureticks will take place, unleſs the Lymphaticks are broke, ſo as to let out the Water into the large Cavitys of the Thorax and Abdomen; and then the Diſeaſe may be look'd upon as deſperate, and will admit of no Cure.

I KNOW that Purging in Dropſys, even with great Violence, is generally indulg'd; and by this means the Waters are often drawn off: but hereby the Stomach, Inteſtines, and glandular Organs of the Abdomen are frequently weaken'd, and over-ſtretch'd to ſuch a degree, that the Waters ſoon collect again, in ſpite of all that can be done to corroborate and ſtrengthen the Organs. And therefore

fore where Diureticks in a Dropſy will not take place at firſt, 'tis certainly the beſt way to proceed directly to Bliſtering; by which a Diſcharge may be made, without weakening and farther ſtretching the Organs. And ſuch is the Safety and great Advantage of this Method, upon ſeveral Accounts, which I cannot now ſtay to enumerate, that I think nothing ought to ſet it aſide for any other, but the Obſtinacy and immoveable Reſolution of the Patient, who may have ſometimes ſuch an unreaſonable Averſion to Bliſtering, as to be abſolutely unperſuadable in this Caſe.

F I N I S.